

Technical Publication 92-02

**A Three-Dimensional Finite Difference
Groundwater Flow Model of the
Surficial Aquifer in Martin County, Florida**

March 1992

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A THREE-DIMENSIONAL FINITE DIFFERENCE GROUND WATER FLOW MODEL OF THE SURFICIAL AQUIFER IN MARTIN COUNTY, FLORIDA

by

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March 1992

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500 292 Produced on recycled paper.**

DRE Inventory Control #310

**Hydrogeology Division
Department of Research and Evaluation
South Florida Water Management District
West Palm Beach, Florida**

EXECUTIVE SUMMARY

This study was undertaken as part of the South Florida Water Management District's Water Supply Planning initiative. One of the water supply planning directives in the initiative is to "develop and maintain resource monitoring networks and applied research programs (such as forecasting models) required to predict the quantity and quality of water available for reasonable-beneficial uses" (SFWMD, 1991). The model will be used within the SFWMD by the Planning Department in the development of the Upper East Coast Water Supply Plan and by the Regulation Department to implement the water use criteria and policies of the District. The Water Supply Plan includes a projection of future water demand, identification of water sources and methods to meet this demand on a regional scale and an analysis of impacts associated with these alternate methods.

New regulatory criteria from water supply plans and the Draft Water Supply Policy Document will be incorporated into the District's Basis of Review for Consumptive Use Permits. The models will also be used for impact analysis in the District's water use regulatory function and on the local scale by governments and consultants. This model is not considered to be an unchanging final product. As new data and technologies are available, it will be upgraded and improved. Future plans include the integration of surface water and water quality elements, Geographic Information Systems (GIS) applications, and the ability to "zoom" in on specific model areas for more detailed local modeling.

Martin County, Florida is underlain by two aquifer systems: the Surficial Aquifer System and the deeper Floridan Aquifer System. Information from a ground water assessment completed by the South Florida Water Management District in 1990 was used to develop a regional three-dimensional ground water flow model. This model focused on the Surficial Aquifer System while a separate model was developed for the Floridan Aquifer System and is documented separately.

For modeling purposes, the Surficial Aquifer System in Martin County was divided into three layers representing different lithologic types: 1) fine sand, silt, and organics, 2) shell, sand and limestone/sandstone with little or no fines, and 3) sand, shell, silt and poorly consolidated, micritic limestone. The second layer is moderately

productive and most ground water is withdrawn from this interval. Productivity in the remainder of the Surficial Aquifer System is low.

The Ground Water Flow Model

The Martin County Surficial Aquifer System model was developed using the U.S. Geological Survey modular three-dimensional finite-difference ground water flow model code, commonly known as MODFLOW. This code was used because it allows a detailed evaluation of ground water flow, is available in the public domain, is compatible with most computer systems, and contains many features which make it easy to use and modify. MODFLOW simulates ground water levels and flow using data describing the aquifers, such as hydraulic conductivity, transmissivity, leakance, and storage. Stress on the aquifers (e.g., recharge, evapotranspiration, well withdrawals, and interactions with surface water bodies) can also be simulated with the model.

The horizontal model grid is composed of 59 rows and 109 columns. A uniform size of 2,000 by 2,000 feet was used, except for five columns of cells on the western edge of the model. These columns increase in width as they extend westward six miles into Okeechobee County.

Recharge to the Surficial Aquifer System

Rainfall provides approximately 95 percent of the total annual aquifer recharge in the study area under present conditions. An additional four percent represents recharge coming primarily from ground water flow into the study area from boundaries, and the final one percent is leakage from rivers.

Discharge/Water Use from the Surficial Aquifer System

Evapotranspiration accounts for approximately 70 percent of the outflow from the model area under present conditions. Leakage to canals in the study area accounts for an additional 19 percent of the losses. Well withdrawals account for an additional nine percent, and the remaining losses are flow out of the model along boundaries.

Well withdrawals for agriculture, public supply, and domestic self-supply were determined by various means. Agricultural ground water withdrawal information for the calibration period was obtained primarily from water use permits

issued by the District. The permits supplied information on crop types, acreages, irrigation practices, and wells. Additional information, when necessary, was obtained directly from the agricultural operators. This information was used to estimate monthly water use during the calibration period. Actual pumpage records were used when available. Data on public supply water use, as reported to the District and to the Florida Department of Environmental Regulation, also was used in the model. Domestic self-supply was estimated based on land use types and irrigation use assumptions.

Calibration/Sensitivity Testing

The model was calibrated by adjusting aquifer parameters within prescribed limits to match computed water levels with monthly observed water levels in monitor wells for the period January 1989 through December 1989. The calibration criteria required that modeled water levels be within one foot of the observed water levels for at least nine of the twelve months modeled, and this criteria was met in fifty-three percent of the wells. For an additional twenty-nine percent of the observation wells used, calibration criteria was not met because of limitations in reporting model levels. The model value used to verify calibration represents the water level at the center of each 2,000 x 2,000 foot cell. Because of the gradient across the cell and the location of the observation well in the cell, the well may not be at the same water level as the level in the center of the cell. However, comparing model values in adjacent cells confirms that the gradient is correct and, therefore, the model does calibrate to the well. Since a majority of the wells verify calibration of the model, there is a high degree of confidence in the model.

To ensure the best possible accuracy for evaluative or predictive purposes, it is important to test the model's sensitivity to the estimated parameters. The model was fairly insensitive to changes in hydraulic parameters, but changes in inputs to the recharge and evapotranspiration packages significantly affected calibration in all three layers of the model.

Recommendations

The most important recharge and discharge sources in the model are rainfall and evapotranspiration; the accuracy of the model depends on the accuracy of the input data for these

two sources. As currently designed, the model provides a simplification of the actual complex processes involved in determining how much rainfall actually reaches the aquifer and how much water is removed from the aquifer by evapotranspiration. Work in these areas is needed to improve model accuracy.

Domestic self supply and irrigation are large users of water in Martin County. In order to enhance the accuracy and reliability of the model for resource availability determinations, improvements in the estimation of domestic self-supply use could be made with better information on exactly where utility boundaries are located and which houses in utility areas use private water for irrigation.

Public water supply utilities that use multiple wells need to record raw water pumpage from each well. Because of differences in pump capacity and the operating schedule of each well, total wellfield pumpage is of limited value in generating model input necessary for determining wellfield impacts. This information is especially important when "zooming" in on an area.

Based on the model budget, discharge to surface water bodies represents a significant loss from the aquifer. Input data, including canal construction details and stage levels, are limited and estimation errors could result in inaccurate seepage amounts into or out of the canals. Efforts should be made in the permitting process to obtain and include this data in future surface water management permits. Stage recorders in major grove canals would provide valuable information on water levels to set in river/drain cells in future modeling efforts.

The model should be used in the evaluation of water use permit applications. Where a finer scale or site-specific model is required, the regional model could be used to provide the boundary conditions. The model should continue to be refined and updated whenever additional information becomes available.

Availability of Model for Use

Electronic copies of model data sets are available upon request from the Hydrogeology Division. If, in using the model, users include new or more detailed data that results in a better calibration, they are encouraged to share that data with the District. Refinement of the model is a continuous, ongoing process.

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ACKNOWLEDGEMENTS

This project was carried out under the direction of Scott Burns, formerly the Director of the Hydrogeology Division and currently Director of the Water Use Division. I would like to thank him for giving me the opportunity to undertake this effort. Keith Smith, Acting Director of the Hydrogeology Division, also provided direction and editorial comments.

The author wishes to acknowledge the peer review committee, whose comments greatly improved the quality of this report:

Leslie Wedderburn, Dept. of Research and Evaluation, SFWMD
William Scott Burns, Water Use Division, SFWMD
Paul Millar, Local Government Assistance, SFWMD
Tom Tessier, Geraghty and Miller
Linda Horne, Martin County Utilities Department
Rick Nevilis, CH2MHill, Deerfield
Gary Russell, USGS, Stuart
Pete Anderson, Geotrans, Inc., Virginia

The author also wishes to thank Emily Hopkins for her prompt and valuable editorial comments.

Jorge Restrepo provided numerous insights into the model as well as several very useful pre and post processing programs for which I am very grateful. I also appreciate all the suggestions I received from my fellow hydrogeologists as I discussed problems I encountered. Especially helpful were the observations and challenges presented by Mary Jo Shine as she evaluated the model, which improved it in several areas.

Gratitude is expressed to Barbara Dickey for her immediate attention and assistance to all problems involving the computer, especially in writing programs to make my job easier. Also to Diane Bello, Janet Wise and Dave Demonstranti for creating wonderful graphics and patiently accepting the tedious modifications. Finally, to Hedy Marshall for her expediency during the compilation of the text and her patience during the editorial phase of this project.

ABSTRACT

In Martin County, Florida, the Surficial Aquifer System is the primary ground water supply source. The Surficial Aquifer System is comprised of a moderately productive zone of sand, shell, and limestone/sandstone intervals overlain and underlain by less productive layers of mainly sand and silt. A three-dimensional ground water flow model of the Surficial Aquifer System was developed using the U.S. Geological Survey modular finite-difference ground water flow model code (MODFLOW). The model consists of three layers representing three lithologic zones. Horizontal discretization was accomplished using a grid comprised of 59 rows and 109 columns, with a grid spacing of 2,000 feet. Initial aquifer parameters were obtained from various agency and consultant reports. A transient calibration was performed for a one-year period (1989) by comparing simulated water levels with observed water levels from an extensive monitoring network. Sensitivity analyses showed that water levels in all layers of the Surficial Aquifer System are sensitive to changes in recharge and the evapotranspiration surface. Work is needed in these two areas to improve model accuracy.

INTRODUCTION

PURPOSE AND SCOPE

This study was undertaken as part of the South Florida Water Management District's program to develop regional comprehensive water supply plans and support regulatory decisions of the agency. These plans will be based on quantitative assessments of the available water resources combined with estimates of future water use demands. Evaluation of existing water supply problem areas, identification of potential problem areas, and development of management guidelines will be integral parts of a water supply plan.

The purpose of this study was to develop a countywide three-dimensional ground water flow model of the Surficial Aquifer System in Martin County. Specific uses of this model will be to develop and evaluate the ground water elements of the water supply plan for the Martin County area and to evaluate the impact of future ground water uses on existing users as part of the regulatory process. The model will also be used to evaluate short-term drought management scenarios during declared water shortages.

This report represents one in a series of ongoing studies to characterize the ground water resource of Martin County. Development of the ground water flow model is documented in this report. The model will be continually refined and updated as it is used in the regulatory and planning processes, and as more data become available. Electronic copies of model data sets are available upon request from the Hydrogeology Division. The modeling work was preceded by extensive field work to define the extent and occurrence of major aquifer systems, regional ground water flow patterns, water-quality trends, and a preliminary assessment of the future development potential of the ground water resources of Martin County. The results of the field work will be described in a SFWMD Technical Publication to be released in 1992.

LOCATION OF STUDY AREA

Martin County is located in southeastern peninsular Florida, east of Lake Okeechobee (Figure 1). It is bounded on the east by the Atlantic Ocean and to the west by Lake Okeechobee and Okeechobee County. To the north and south, it is bordered by St. Lucie and Palm Beach Counties, respectively. The

county is 35 miles from east to west and 16 miles from north to south. The study area includes most of Martin County, a six-mile buffer area into adjacent Okeechobee County, and five miles into northern Palm Beach County. A buffer zone was not extended into St. Lucie County because model development was coordinated with a similar modeling effort in St. Lucie County (Padgett, in press) with the intent of eventually combining the two models. The Jensen Beach peninsula, north of the St. Lucie Inlet and within the political boundaries of Martin County, is actually part of the St. Lucie County ground water flow regime. Therefore, it is included in the St. Lucie Surficial Aquifer System model rather than the Martin County model. The modeled area lies generally within Townships 40 through 43 South, and Ranges 36 through 43 East, and encompasses approximately 720 square miles, 550 of which are in Martin County (Figure 2).

TOPOGRAPHY AND PHYSIOGRAPHY

Martin County lies within the Atlantic Coast Lowlands (White, 1970) and includes the Eastern Valley, the Osceola Plain and the Everglades physiographic regions. Each region has similar topography or relief, or a certain soil type if common. The topography (based on USGS quadrangle maps) and soil types (after McCollum, 1981) in Martin County are illustrated in Figure 3. Most of Martin County lies within the Eastern Valley, which is a broad, flat relict beach ridge plain. In the central portion of the county, between the Osceola Plain and Green Ridge (see Figure 2), this is evidenced by the closely spaced system of subparallel ridges and swales oriented parallel with the present Atlantic beach (White, 1970). Elevations in the Eastern Valley range from 15 to 30 feet above mean sea level. The Osceola Plain ends in a narrow terrace in Martin County and appears to have been a narrow peninsula or series of islands and shoals at one time. It is approximately two miles wide in Martin County and has an elevation of 30 to 50 feet above mean sea level. Located adjacent to Lake Okeechobee in the southwest corner of the county, is the Everglades region which is flat and covered by organic soils formed by the growth and decay of sawgrass. Elevations in the Everglades range from 15 to 20 feet above sea level.

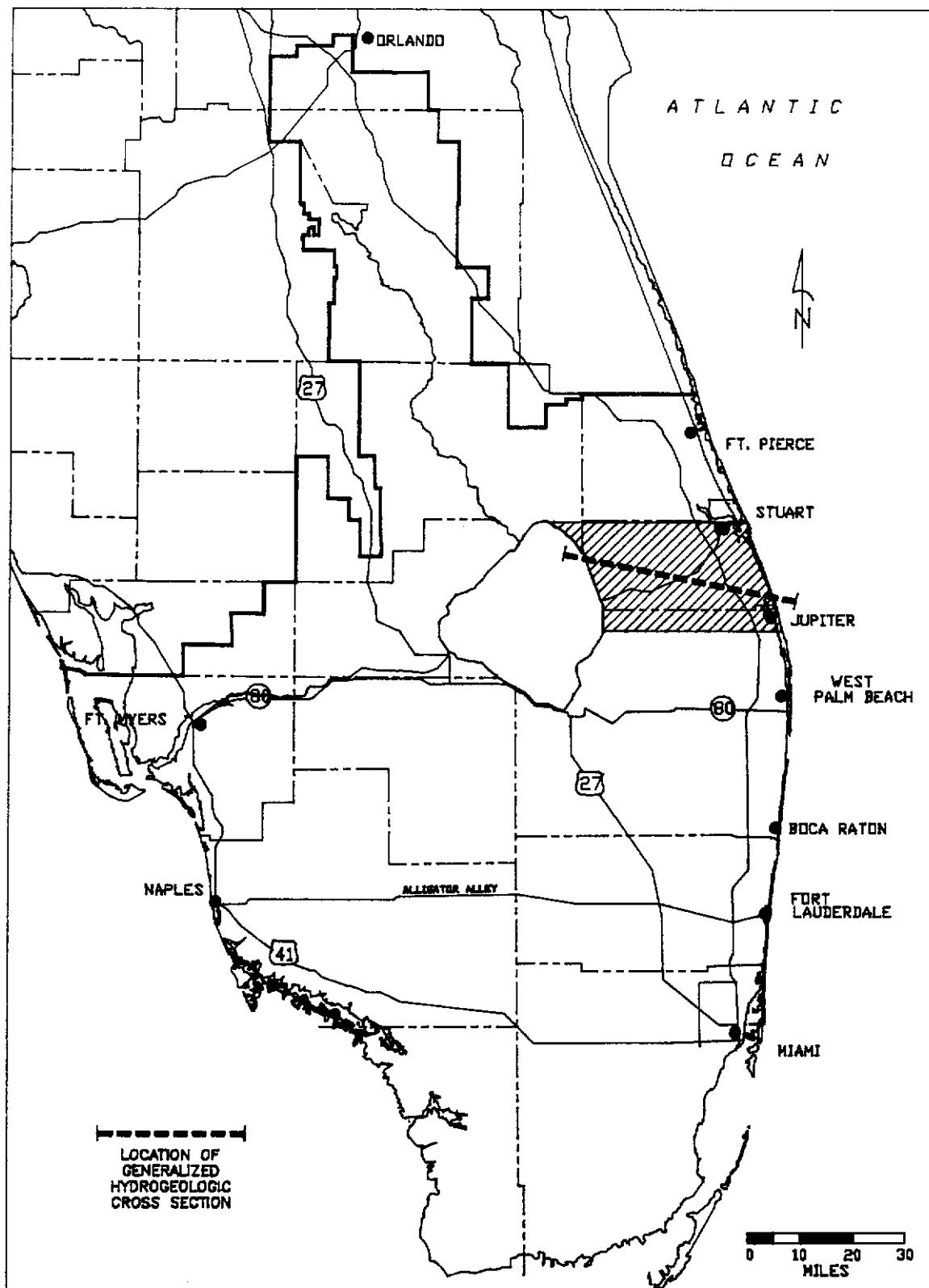


FIGURE 1. Location of Study Area

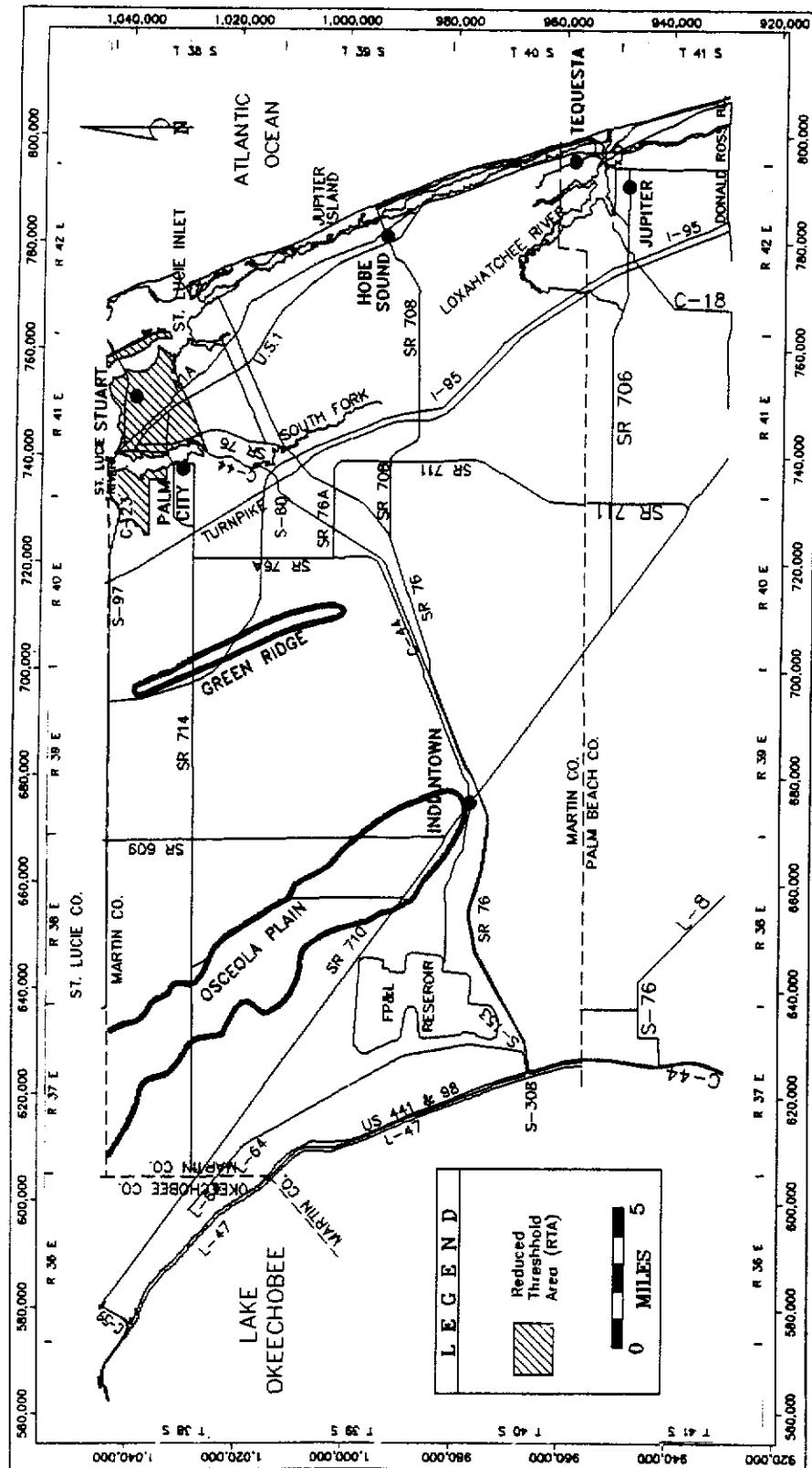


FIGURE 2. Study Area Including Reduced Threshold Areas

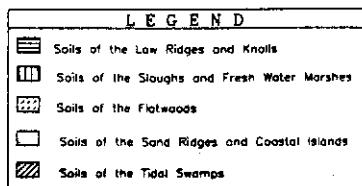
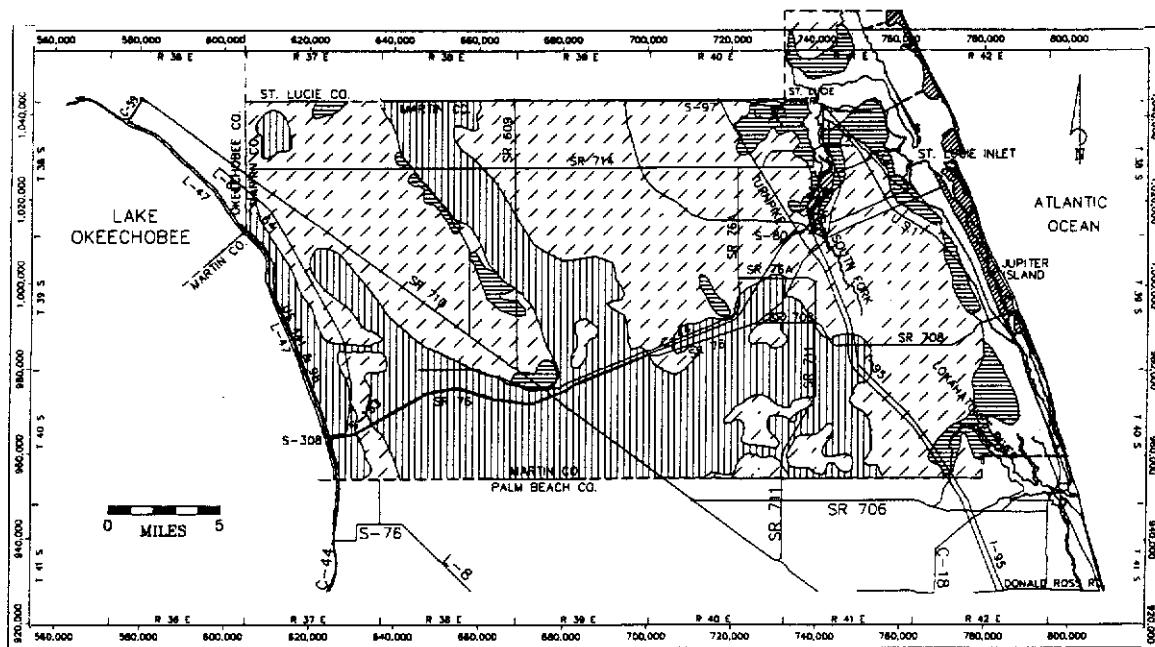
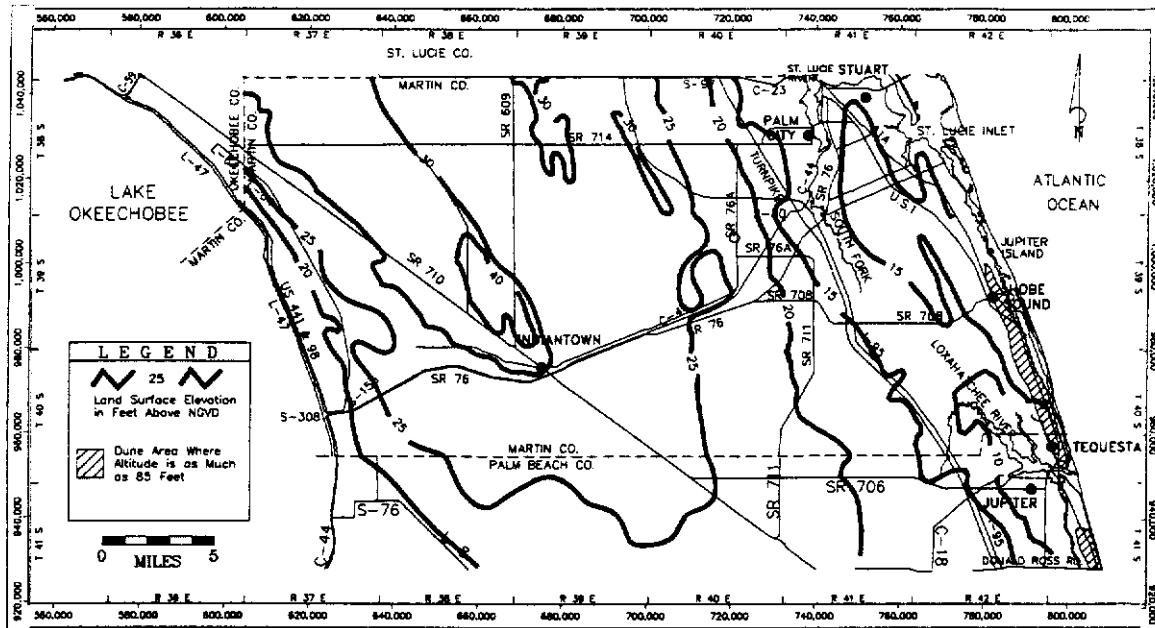


FIGURE 3. Topography and General Soils Maps of Martin County

PREVIOUS INVESTIGATIONS

The hydrogeology of southeastern Florida was generally examined by Parker (1955). A detailed investigation of the water resources of Martin County was performed by Lichtler (1960). The water resources of the county were revisited by Earle (1975) and Miller (1978) also within this same planning area. Stodghill and Stewart (1984) used surface DC resistivity surveys to delineate the hydrostratigraphic zones of the coastal ridge aquifer in Martin County. Nealon and others (1987) provided a regional analysis of water availability and water resource planning recommendations. A number of authors have also provided information on the county's aquifers, but on a site-specific basis.

MacVicar and others (1984) examined the ground water flow of the Surficial Aquifer System in Martin, St. Lucie and eastern Okeechobee counties (Upper East Coast Planning Area) using the South Florida Water Management Model. Nealon and others (1987), refined the grid spacing of the Upper East Coast South Florida Water Management Model to simulate hydrogeologic conditions in Martin County and a portion of St. Lucie County. Three-dimensional ground water flow models have been developed and published for Palm Beach County (Shine, et al., 1990) and for the Jensen Beach Peninsula (Hopkins, 1991). Models for the St. Lucie County Surficial Aquifer System and for the Floridan Aquifer System underlying Martin, St. Lucie, and portions of Okeechobee, Indian River and Palm Beach Counties have been developed and documentation is currently underway.

HYDROGEOLOGY OF THE SURFICIAL AQUIFER SYSTEM

A brief summary of the hydrogeology which supports the model development follows. Readers wishing a more detailed discussion of the hydrogeology of the Martin County area are referred to Adams (in press). Hydrostratigraphic nomenclature used in this report is consistent with guidelines set forth by the Southeastern Geological Society Committee on Florida Hydrostratigraphy (SGSCFH, 1986).

Martin County is underlain by two aquifer systems: the Surficial Aquifer System and the Floridan Aquifer System. The model developed for this study was limited to the Surficial Aquifer System (Figure 4). The Floridan Aquifer System, being modeled separately, is not discussed in this report, but will be the subject of a forthcoming publication (Lukasiewicz, in press).

The Surficial Aquifer System consists of the water table aquifer and hydraulically connected units above the top of the first occurrence of laterally extensive and vertically persistent beds of much lower permeability (SGSCFH, 1986). In Martin County, the Surficial Aquifer System is unconfined to semi-confined and is comprised of three hydrogeologic zones: the surficial sands, the primary water-producing zone, and a less permeable zone overlying the confining bed. The surficial sands are shallow and may not be completely saturated throughout the year. The primary water-producing zone consists of sand, shell, and relatively thin beds or lenses of sandstone/limestone. The less permeable zone is delineated as a sand, silt, shell and soft micritic limestone portion of the Tamiami Formation.

Generally, the surficial sands range in thickness between 20 to 40 feet. These sands have low to medium permeability and may produce small quantities of water (Lichtler, 1960). These sands range in size from very fine to coarse with fine grain being prevalent. Also included in this zone is organic material including "hardpan" units and interbedded lenses of sandy clay and silt.

The major producing zone ranges in thickness from 20 to 250 feet, averaging approximately 130 to 150 feet. The producing zone is capable of providing relatively large quantities of water depending on aquifer characteristics. Transmissivity is the term related to the water-transmitting capacity of the aquifer at a site. Values of transmissivity for 53 sites in Martin and adjacent counties, were collected from various agencies and consultant reports. Of the 53 tests, 37 were used to generate input data sets for the model (see Table 1 and Figure 5 which includes only those tests that were used), while the remaining tests were not used due to questionable data or lack of documentation. In general, transmissivity values countywide are around 4,000 ft²/day (30,000 gpd/ft) but increase to the east and south, with transmissivity values of over 13,000 ft²/day (100,000 gpd/ft) at the Martin/Palm Beach County line along the coast. The permeable limestone and sandstone strata are more prevalent towards the east (Lichtler, 1960) and the thickness of this zone is greater in this area. However, in the Stuart area, located in the northeast part of the model, transmissivities remain around 4,000 to 6,700 ft²/day (30,000-50,000 gpd/ft). This lower transmissivity, when compared to the other coastal area values in the model area, may be due to the higher clay percentage within the aquifer in this area (Miller, 1978).

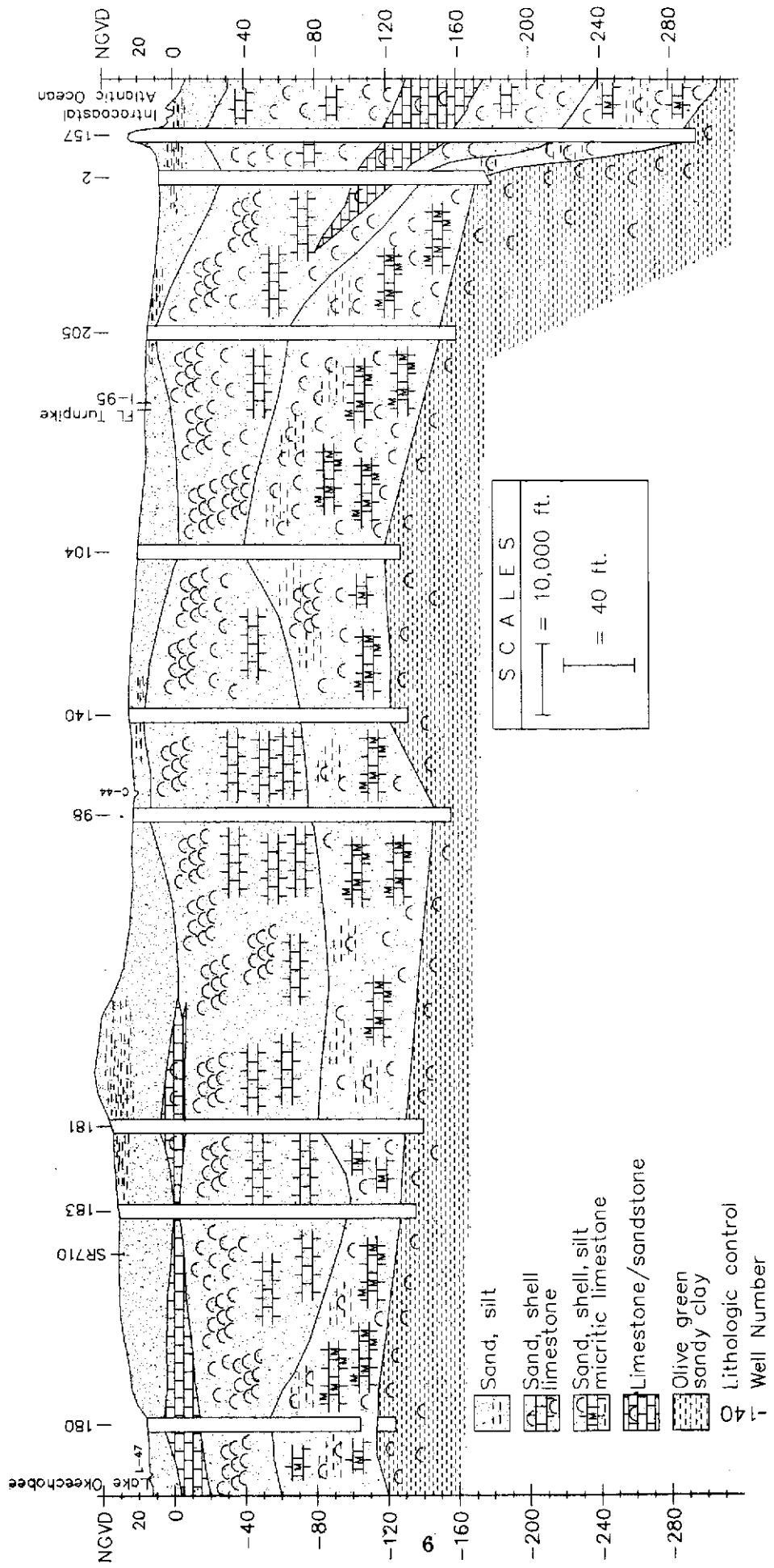


FIGURE 4. Generalized Hydrogeologic Cross Section

TABLE 1: AQUIFER PERFORMANCE TEST DATA USED IN MODEL

MAP #	TEST NAME	STATE PLANE COORDINATES		TRANS-MISSIVITY (ft ² /day)	ANALYSIS METHOD	THICKNESS OF PRODUCING INTERVAL (ft)	HYDRAULIC CONDUCTIVITY (ft/day)	STORATIVITY	SOURCE
		X	Y						
1	C-23	641000	1043900	3610	Neuman	80	45	3x10 ⁻³	SFWMD
2	L-65	614400	1008600	3743	Neuman	70	53	6x10 ⁻⁴	SFWMD
4	McCarty Ranch	662850	1058300	1337	Hantush-Jacob	40	33	3x10 ⁻³	USGS
5	Allapatah	668120	1002250	3476	Boulton	60	58		SFWMD
6	Caulkins	704550	996900	6016	Neuman	120	50	3x10 ⁻⁴	SFWMD
8	Martin Downs	721850	1036350	12032	Boulton	120	100	3x10 ⁻³	Gee & Jenson
9	Leighton Farms	723300	1018750	4679	Cooper	60	78	2x10 ⁻²	USGS
10	St. Lucie Falls	729300	1004450	2674	Jacob	84	32		Lindahl Browning
13	Stuart South	749250	1029350	4011	Jacob	100	40	1x10 ⁻⁴	CH2M Hill
14	Banyan Bay	744400	1021850	4011	Hantush-Jacob	95	42	3x10 ⁻²	Gee & Jenson
15	Miles Grant	766000	1022250	6016	Boulton	115	52	7x10 ⁻⁴	Gee & Jenson
16	Hydratech	775850	1005300	7353	? type curve	160	49	3x10 ⁻³	G. Bobo & Assoc.
17	Hobe Sound	779850	996200	2005	Hantush-Jacob	40	50	1x10 ⁻⁴	USGS
18	J.D.S.P. North	789300	972900	11364	Hantush-Jacob	160	71	2x10 ⁻⁴	USGS
20	Woodside	733850	1041450	4011	Hantush	120	33	2x10 ⁻³	Geraghty & Miller
21	Pipers Landing	737350	1023500	5348	? type curve	90	59	1x10 ⁻⁴	CH2M Hill
24	GDC-Martin Co.	716300	1039300	4011	Recovery	65	62		Geraghty & Miller
27	Harbour Ridge 2	726750	1045400	8021	Cooper	83	97		Geraghty & Miller
30	SR 76	745300	1028000	3342	Neuman	100	33	3x10 ⁻⁴	SFWMD

* Value different than source data.

**Geraghty and Miller repeated the tests originally performed by Bechtel.

TABLE 1: AQUIFER PERFORMANCE TEST DATA USED IN MODEL (CONTINUED)

MAP #	TEST NAME	STATE PLANE COORDINATES		TRANS-MISSIVITY (ft ² /day)	ANALYSIS METHOD	THICKNESS OF PRODUCING INTERVAL (ft)	HYDRAULIC CONDUCTIVITY (ft/day)	STORATIVITY	SOURCE
		X	Y						
31	Stuart	746432	1038737	3342	Cooper	100	33	1x10 ⁻²	USGS
32	Jupiter #13	783667	943147	8021	Boulton	165	49	1x10 ⁻³	Geraghty & Miller
33	PB Co Site 15	760300	946150	2674*	Jacob	76	35	9x10 ⁻⁴	USGS
34	PB Pk. of Comm.	736400	936200	2005*	Neuman	55	36	4x10 ⁻⁴	Howard Searcy
37	Tequesta #5	796500	959600	26738	Boulton	220	121	2x10 ⁻¹	Gee & Jenson
38	Bechtel FPL 1	652354	991086	1872*	Cooper	35	53	3x10 ⁻⁴	Bechtel/G&M**
39	Bechtel FPL 2	652258	977089	2406*	Cooper	45	53	2x10 ⁻⁴	Bechtel/G&M**
40	Bechtel FPL 3	643646	995507	3342*	Cooper	70	48	6x10 ⁻⁴	Bechtel/G&M**
42	J.D.S.P.	771850	979525	3342	Neuman	90	37	5x10 ⁻⁴	SFWMD
43	Mobil/TP&J	750900	1003700	2005	Neuman	53	38	2x10 ⁻⁴	SFWMD
45	Monreve Ranch	728050	986500	3342	Neuman	60	56	2x10 ⁻⁴	SFWMD
46	Vista Salerno	761400	1015600	3342*	Neuman	100	33	8x10 ⁻³	?
47	P.B. Co. Site 14	731213	918686	4412	Jacob	100	44	5x10 ⁻⁵	USGS
49	Jonathans Land.	795300	939500	10027	Boulton	110	91	2x10 ⁻⁴	Gee & Jenson
50	Maplewood	785750	939200	5214	Hantush-Jacob	90	58	3x10 ⁻⁴	Adair & Brady
51	Mecca	787600	930200	5749	Recovery	100	57		Geraghty & Miller
52	Hobe Sound 14	781750	988200	22727	Hantush	180	126		J. M. Montgomery
53	Hobe Sound 15	780900	988900	10695	Neuman	140	76		J. M. Montgomery

* Value different than source data.

**Geraghty and Miller repeated the tests originally performed by Bechtel.

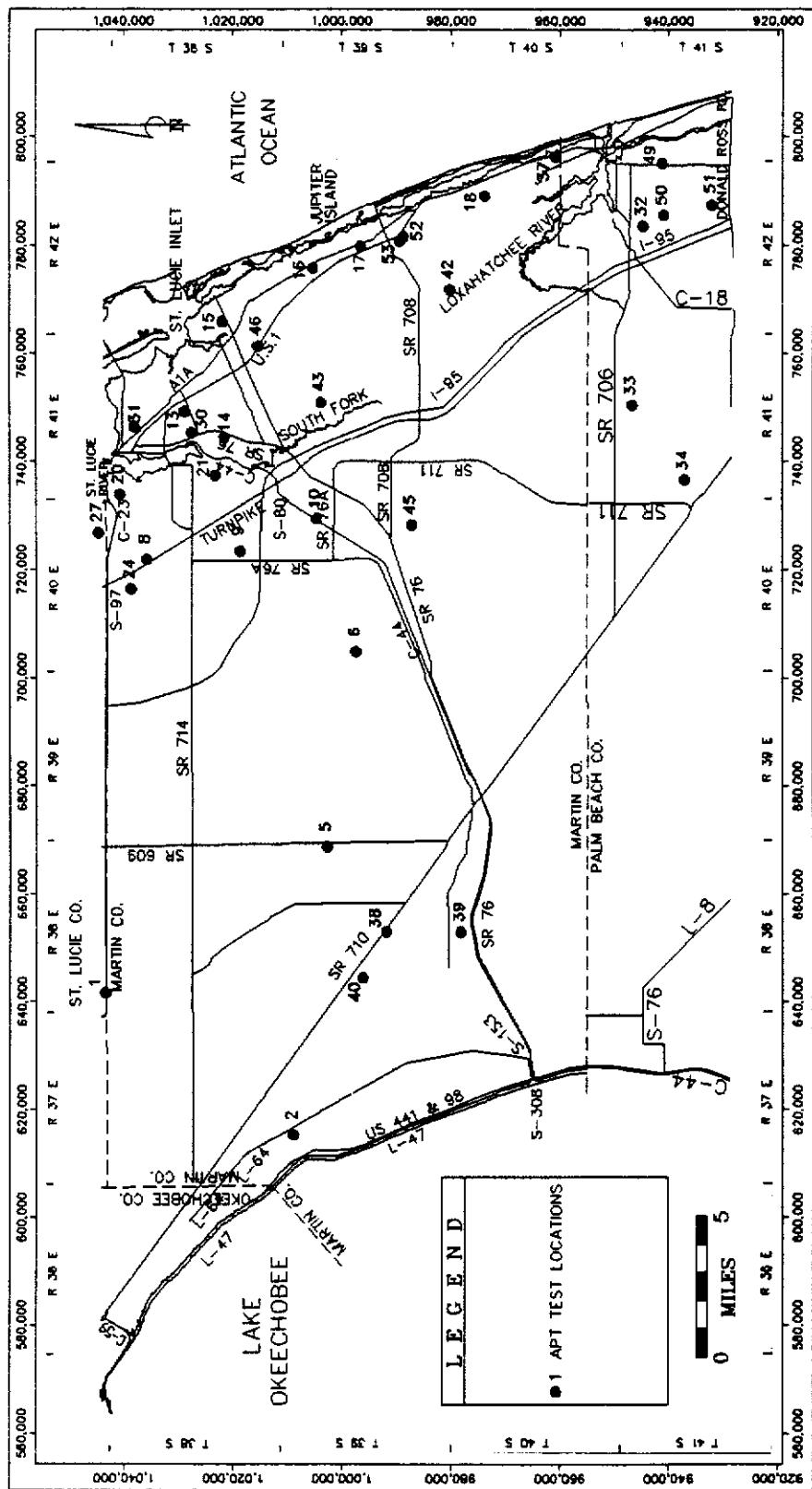


FIGURE 5. Locations of Aquifer Performance Tests in Model

The less permeable zone found below the main producing zone is significant in its ability to store water and release it to the producing zone if needed. Wells completed in this zone do not often yield useful quantities of water as the presence of silts and fine-grained, poorly consolidated limestones reduces its transmissivity. The base of this zone was defined as that point where the percentage clay content became significant enough to essentially prevent the release of water to wells or the producing zone.

MODEL DESCRIPTION

OVERVIEW

In this study, the U. S. Geological Survey modular three-dimensional finite-difference ground water flow model code (McDonald and Harbaugh, 1988), commonly known as MODFLOW, was used. This model code was selected for the following reasons:

1. It is available in the public domain,
2. It is compatible with most computers with only minor modification,
3. The modular structure of the code and its excellent documentation allow easy modification of the code and the addition of new modules for specialty applications,
4. MODFLOW allows great flexibility of data file structure and management; this facilitates the employment of and interaction with other software for data manipulation,
5. The cell-by-cell flow feature of the code can be used to:
 - A. Evaluate in detail flow and head changes associated with various withdrawal scenarios, and
 - B. Generate boundary conditions for higher-resolution models within the regional flow model, and
6. It can be coupled with currently available non-density dependent solute transport models.

The hydrologic properties or conditions which the model can represent include:

- The aquifer properties of hydraulic conductivity or transmissivity, storage capacity, and vertical conductance.
- Initial water level conditions.
- Recharge.
- Evapotranspiration (ET).
- Rivers and drains. Rivers can both drain and recharge the aquifer, depending on the relationship of river and aquifer heads; drains do not recharge.
- Wells, as either discharge or recharge.

Three iterative solution schemes are available for solving the finite difference equations governing flow in porous media: slice-successive over relaxation (SSOR), strongly implicit procedure (SIP), and the preconditioned conjugate gradient (PCG) method (Kuiper, 1987). The SIP method was used in this study and after adjusting the acceleration parameter down to 0.5, it worked well. SSOR is the better solution method for some strongly layered conditions. However, it is not as direct as SIP, therefore, it generally requires more time to arrive at a solution. Table 2 summarizes the modules and their application to the Martin County model.

DISCRETIZATION

Discretization is the process of breaking up a continuous system into a set of discrete cells defined by a system of rows in a horizontal plane and columns in a vertical plane, to represent the system numerically. The study area was discretized into a horizontal grid comprised of 2,000 ft² cells, assembled into a grid of 59 rows and 109 columns (Figure 6). The westernmost five columns of cells were expanded into Okeechobee County as shown in Figure 4 to provide a buffer zone.

The Martin County model contains three layers (Figure 7). The layers were determined by lithology from 224 wells. Locations, information source and breakdown into model layers for each well used in this study, as well as structure contour maps, can be found in Appendix A. Layer one, beginning at land surface, consists of fine sand, silt and organics; layer two is made up of sand, shell, and mostly thin layers of limestone/sandstone with little or no fines; and layer three is similar to layer two but contains silt/clay and the limestone is generally soft and micritic. In coastal areas, there are some minor confining units which define additional layers; however, they pinch out quickly to the west and were not considered significant on a regional scale. The surficial sands, generally in the eastern portion of the county, contain one or more "hardpan" units (layers of low permeability composed primarily of fine sand and organic material) within a few feet of land surface. In the Hopkins (1991) study of the Jensen Beach Peninsula, the hardpan, where present, was found to vary greatly in thickness and depth over very small distances. It was assumed that this variability would occur throughout the county;

TABLE 2.
PACKAGES IN MODFLOW USED IN THE MARTIN COUNTY MODEL

MODFLOW PACKAGE	FUNCTION	USE IN MODEL
BASIC	Model Administration	Used
BLOCK CENTERED FLOW	Computation of conductance and storage components of finite-difference equations.	Used
RIVER	Simulates effects of river leakage. Rivers may recharge or drain the aquifer depending on the head gradient between the river and the aquifer.	Used to represent C23, C44, L8, L47, L63, L64, L65, C59, Intra-coastal, salt/brackish Loxahatchee, C18, St. Lucie River, controlled drainage district canals in Jupiter wellfield area.
RECHARGE	Simulates recharge to the aquifer from infiltration of precipitation.	Used with measured precipitation: a pre-processor program calculates losses to interception/evaporation and runoff.
WELL	Simulates a source/sink to the aquifer that is not affected by heads in the aquifer.	Used to represent discharge from public water supply, domestic self supply, and irrigation water use.
DRAIN	Simulates discharge from the aquifer to drains.	Used to represent all drainage district canals with unmaintained water levels, all grove canals, ranch canals, upstream St. Lucie River & Forks, upstream Loxahatchee River & Forks.
EVAPO-TRANSPERSION	Simulates evapotranspiration where the source of water is the saturated porous medium.	Used modified Blaney-Criddle calculation: coefficients estimated by land use types.
GENERAL HEAD BOUNDARY	Simulates a source/sink of water providing recharge/discharge to the aquifer at a rate proportional to the head difference between the source/sink and the aquifer.	Used along all model boundaries, and to represent Lake Okeechobee, Atlantic Ocean, St. Lucie & Jupiter Inlets, FP&L Reservoir.
STRONGLY IMPLICIT PROCEDURE (SIP)	Solves the model's finite difference equations using the Strongly Implicit Procedure.	Used
OBSERVATION NODES	Generates a file of computed water levels for selected model cells.	Used to generate comparative hydrographs and calibration agreement.

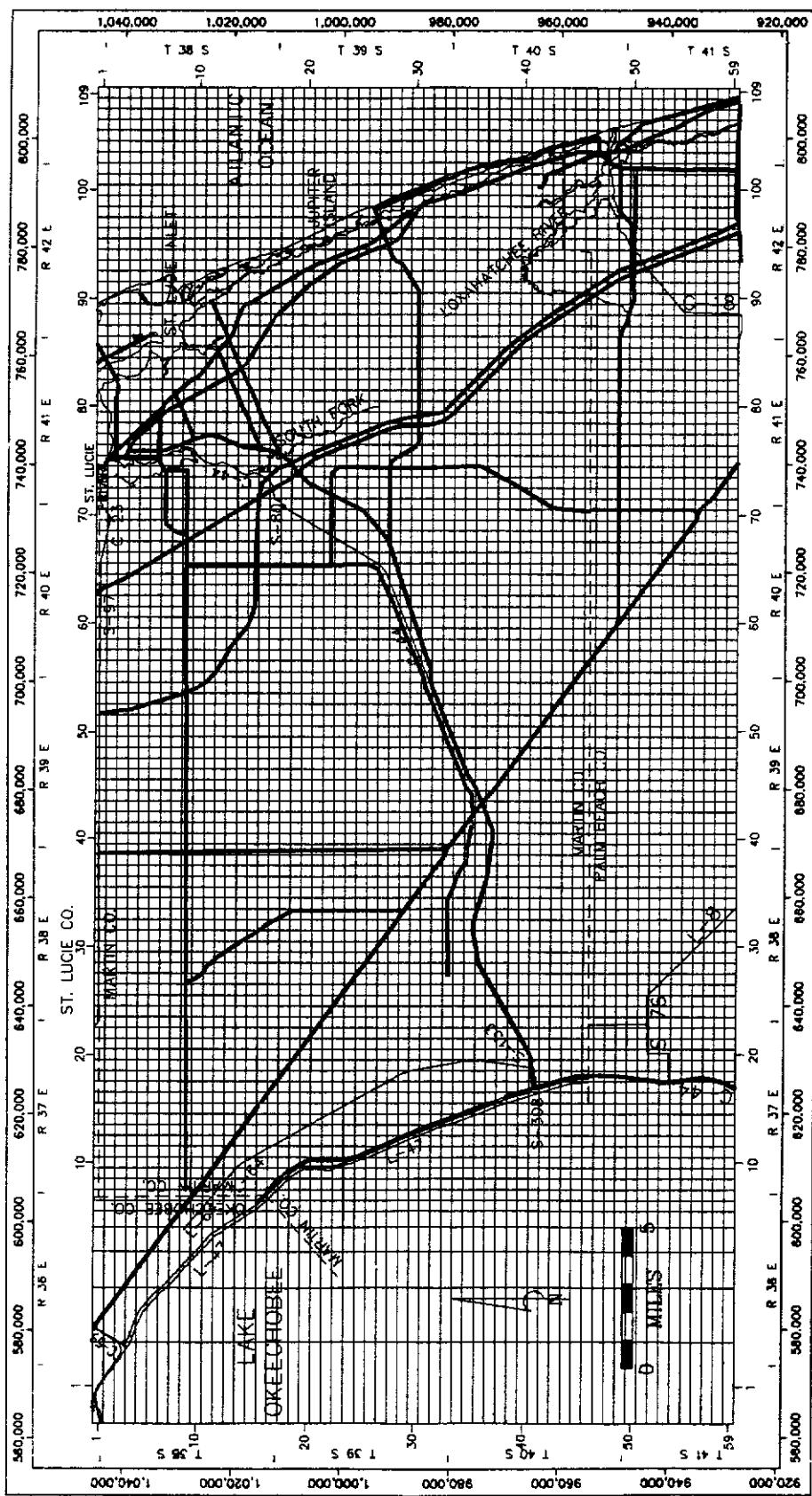


FIGURE 6. Model Grid

General Lithology	Lithology Schematic	General Hydraulic Characteristics	Model Layer
very fine to medium quartz sand with silty intervals, organics		low permeability	1
calcite cemented sand to sand, shell and thin limestone intervals to well cemented sandy biogenic limestone		moderate permeability	2
sand, shell, silt and moderate to poorly cemented micritic limestone		low permeability	3
olive green sandy silt/clay		very low permeability	base no flow boundary

FIGURE 7. Lithologic Types and Corresponding Model Layers

therefore, these units were not specifically included in the model. Layer one thickness values ranged from 15 feet to 75 feet, layer two thickness from 20 feet to 262 feet and layer three thickness from 15 feet to 139 feet.

BOUNDARY CONDITIONS

The function of boundaries is to impose the effects of the external regional flow system on the modeled area. Several types of boundary conditions are available in MODFLOW including prescribed head and prescribed flux. Constant head boundaries, where the head at the boundary remains constant for the model duration, are one example of a prescribed head boundary. Prescribed flux boundaries are used when there is a flux which changes with time at the outer edges of the boundaries. No-flow boundaries are a type of prescribed flux boundary where the flow regime is such that flow across the boundary is not expected to occur. In head-dependent flux boundaries, the flux is dependent on the head in the cell and the head assigned to the external source. Head-dependent fluxes in MODFLOW include general head boundaries, rivers, drains and evapotranspiration. With prescribed head, another type of head-dependent flux boundary, the flux can be as large as needed. A no-flow boundary is implicit along the outer edges and bottom layer of the model.

The general head boundary package was used to generate head-dependent flux and prescribed head boundaries. According to McDonald and Harbaugh (1988), a general head boundary consists of a water source outside the model area which supplies or removes water to a model cell at a rate proportional to the head difference between the source and the cell. A horizontal conductance term is also included in the general head flow calculation and its value is initially based on the length, width, sediment thickness and horizontal hydraulic conductivity of the cell (see Figure 8). A dimensionless calibration factor is included when necessary.

The Atlantic Ocean borders the entire eastern edge of the model, and Lake Okeechobee borders most of the western edge. These two large water bodies provide a constant source of water which can be considered a head dependent flow boundary. Measured water levels in Lake Okeechobee varied from 11.31 to 14.27 feet NGVD in 1989 and the Atlantic Ocean varied from a low of -0.07 feet NGVD in June to a high of 1.35 feet NGVD in October. The general head package was used to represent these boundaries because of its flexibility to vary heads. In layer one, the boundary cells are in direct contact with the ocean or lake. Accordingly, horizontal

conductance values were set large enough to provide an unlimited source/sink of water, thereby acting as a prescribed head boundary. Conductances for these prescribed head cells were calculated using the following formula (see Figure 8 for conceptualization):

$$\frac{KLW}{M} * \text{multiplier} \quad (1)$$

where

$$\begin{aligned} K &= \text{layer one hydraulic conductivity (ft/day)} \\ L &= \text{layer thickness} \\ W &= \text{width of column} \\ M &= 1 \\ \text{multiplier} &= 2,000 \text{ (used as a calibration parameter)} \end{aligned}$$

As previously discussed, flow between the general head and the cell containing it is controlled by the conductance term and head differences. Layers two and three represent fully saturated aquifers and were assumed not to be in direct contact with the ocean and lake; therefore, conductances were calculated based on the transmissivity of the cell. General head conductances were calculated using the following formula (see Figure 8 for conceptualization):

$$\frac{TW}{M} \quad (2)$$

where

$$\begin{aligned} T &= \text{transmissivity} \\ W &= \text{width of cell containing general head and adjoining active cell face} \\ M &= \text{distance from edge of cell adjacent to water source and center of cell} \end{aligned}$$

The C-23 canal and the St. Lucie River and Inlet are assumed to act as ground water divides along the northern edge of the model and are, therefore, used as boundaries. In a strict sense, the C-23 canal is not a true divide since it vertically penetrates only a small part of the aquifer. However, observed water levels indicate that the canal is acting as a divide under current non-stressed conditions. Significant stress on the aquifer near the C-23 canal could cause flow under the canal; the model's boundary should be adjusted accordingly if such stresses occur or must be simulated. The C-23 canal is represented by river cells in layer one and by general head cells in layers two and three (those cells directly beneath the C-23 canal) (see Figure 8). The general head cells were used to simulate conditions

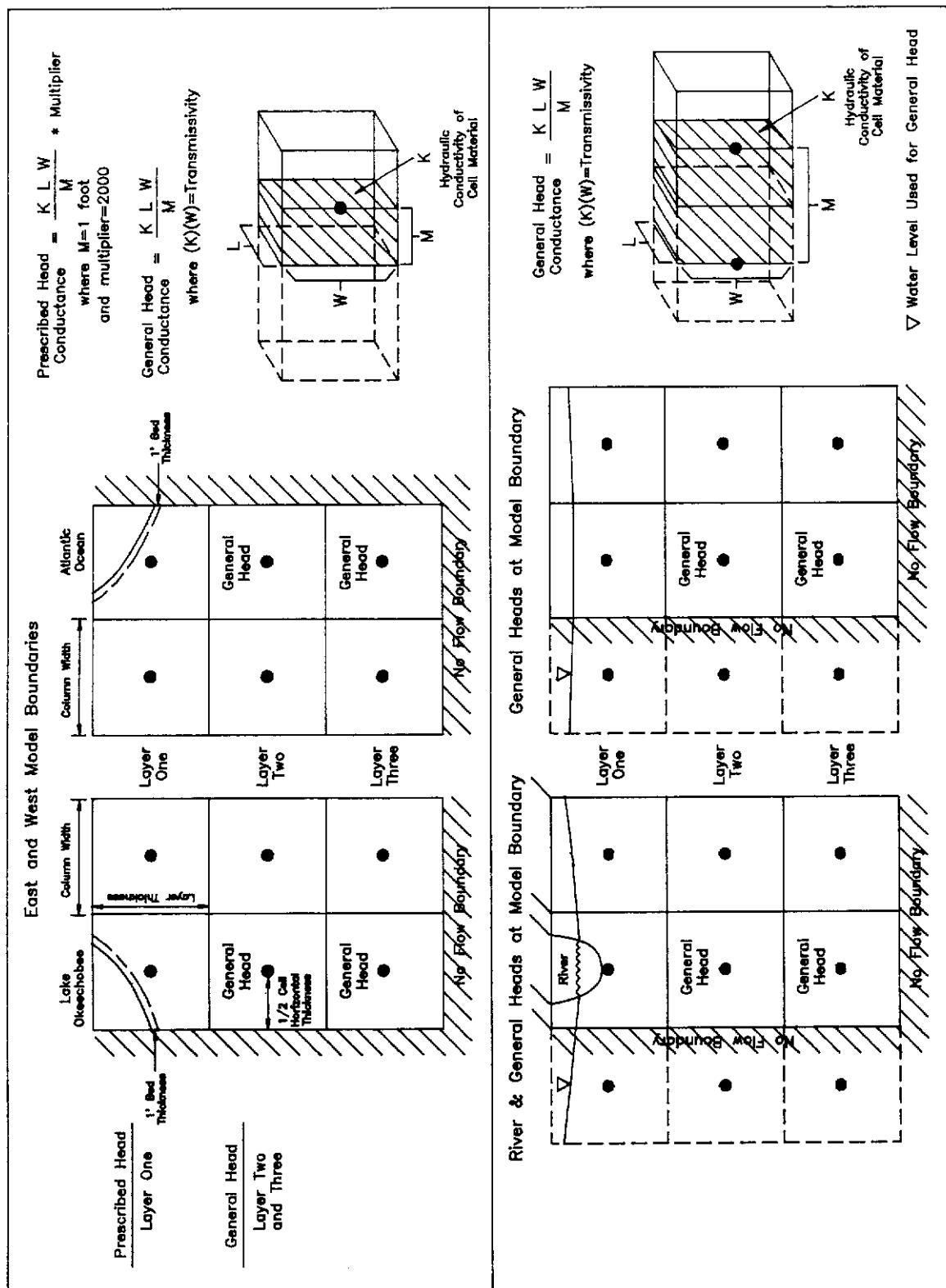


FIGURE 8. General Head Boundary Conceptualization

outside the model, therefore, head values were matched to water levels on the other side of C-23 in St. Lucie County. Conductances of the general heads are equal to the transmissivity of the cell. The C-23 canal runs most of the length of the northern model boundary except for the six westernmost miles of the Martin/St. Lucie border, and the six miles in the Okeechobee County portion of the north model boundary. There are no specific hydraulic boundaries along this northwest corner of the model. However, water level contour maps indicate that flow is occurring either in or out of the model along this boundary. There is a relict beach ridge just west of the western end of the C-23 canal which causes a ground water gradient into the Martin model. Using statistically generated water level maps, head values along the boundaries were approximated and these approximations were input as general heads. The approximated head value for each cell was used for all three layers and for all stress periods. Further refinements could be made in this area if more data were available. General head conductances for layers two and three were calculated using equation 2, and conductances for layer one, west of the C-23 canal, were calculated as follows:

$$\frac{KLW}{M} \quad (3)$$

where

- K = hydraulic conductivity of cell (ft/day)
- L = length of face along general head cell and adjoining active cell
- W = layer one thickness minus five feet
- M = distance between outside source water level and center of general head cell

The five feet subtracted from the layer one thickness number represents a countywide average unsaturated zone thickness.

The southern boundary of the model was based on a need to extend far enough into Palm Beach County to insure validity of the model at the Martin/Palm Beach county line. The boundary was located midway between the cones of influence of the Town of Jupiter and Seacoast Utilities wellfields. The southwest portion of the model boundary includes the Corbett Wildlife Management Area where water levels are flat for great distances. Some areas along the boundary do meet the no-flow definition, however, in order to simplify the boundary file by making cell types the same, all southern boundary cells contain a general head source/sink. Using statistically generated water level maps, head values along these boundaries were

estimated, and these estimations were input as general heads. The estimated head value for each cell was used for all three layers and for all stress periods. Constant head cells could also have been used, however, constant head cells do not provide the conductance term which can be used to calibrate the simulated sources and sinks outside the model boundaries. Equation 3 was used for layer one and equation 2 was used for layers two and three to calculate the general head conductance term. Locations of the various boundaries can be found in Figures 9 and 10.

HYDRAULIC CHARACTERISTICS

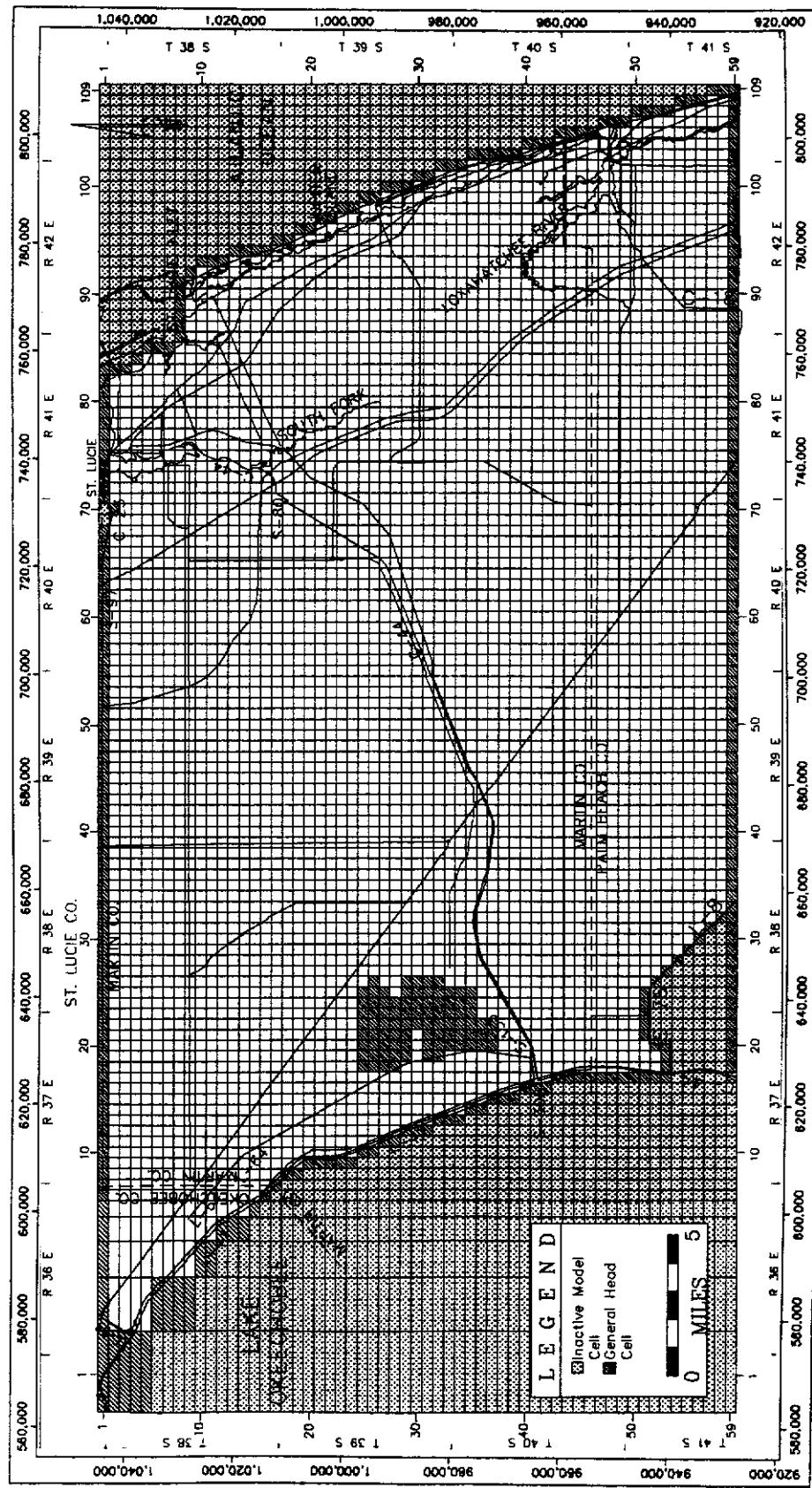
The Surficial Aquifer System is heterogeneous and anisotropic as a result of its widely varied composition. The system is composed of sand or sand/shell layers with intermixed thin to fairly continuous limestone/sandstone beds. Hydraulic conductivities in the system estimated from pumping tests range from 25 to 180 ft/day with an average value of 50 ft/day.

The system was divided into three hydraulic conductivity zones for modeling purposes: a low permeability zone representing the uppermost fine sand/silt lithology; a zone of intermediate permeability representing the production zone tapped by most wells; and another low permeability zone representing the remainder of the system.

Transmissivity/Hydraulic Conductivity

MODFLOW requires that each layer of a model be classified as either confined, unconfined or some combination of the two. All three layers of the model are part of an unconfined system, however, MODFLOW only allows one layer be designated as unconfined. For this reason, layer one was defined as unconfined, layer two was defined as confined/unconfined and layer three was designated as confined (since the entire thickness of layer three will always be completely saturated). These designations determine how heads are calculated in each layer. In an unconfined layer, transmissivity is continually recalculated as a function of hydraulic conductivity and the saturated thickness of the layer. Storage is determined from specific yield. Under the confined/unconfined designation, it is assumed that the majority of the layer will remain saturated throughout the simulation, so transmissivity is not continually recalculated. This layer type requires the input of both a specific yield and a storage coefficient, so that the appropriate storage factor may be used depending on if it is confined or unconfined. In the confined designation,

FIGURE 9. Cell Types, Layer 1



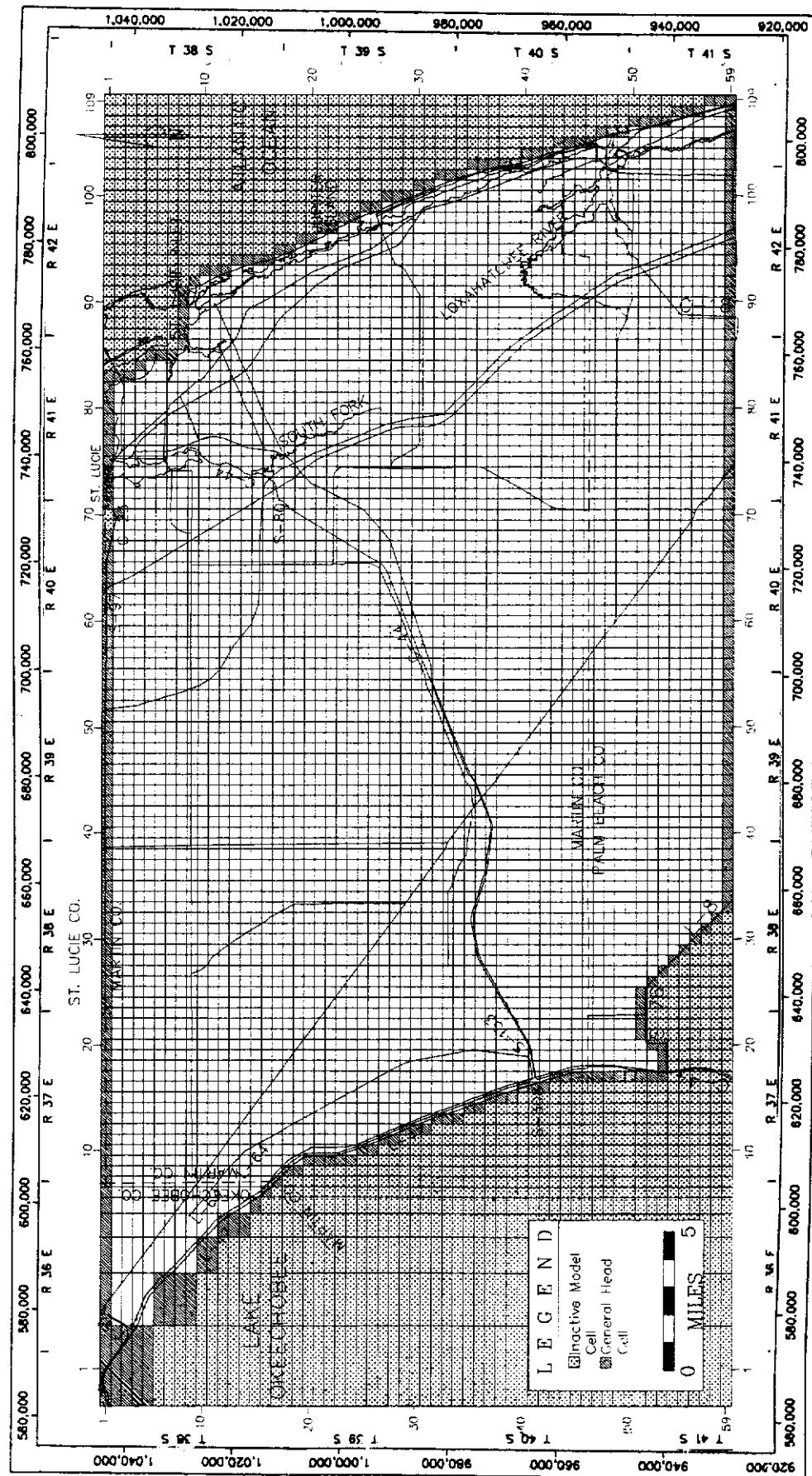


FIGURE 10. Cell Types, Layers 2 and 3

transmissivity and storage coefficients are kept constant for the entire simulation.

Layer One. MODFLOW calculates the transmissivity of unconfined aquifers by multiplying the hydraulic conductivity by the saturated thickness of the aquifer. Initial saturated thickness is calculated from the starting head and aquifer bottom data, both of which are required input for an unconfined aquifer. Head changes throughout the simulation result in changes in the calculated transmissivity in an unconfined aquifer. When the simulated head in a cell drops to a level at or below the aquifer bottom elevation, the transmissivity of the cell becomes zero, resulting in the cell "going dry" and becoming inactive for the remainder of the simulation.

Little data exist on the hydraulic conductivity of zone 1 (layer one) of the Surficial Aquifer System in Martin County. Originally a single hydraulic conductivity value of 20 feet per day was chosen. When a soils map with differing values of vertical hydraulic conductance was created for another package in MODFLOW, the distribution and range of values seemed reasonable for use as a layer one hydraulic conductivity array. Table 3 lists the various soil types in the model area and the conductivity used for each type. Values range from 3 feet/day in sloughs and river beds to 47 ft/day along the coastal dunes, with a large portion of the county being 12 ft/day. A weighted conductivity value based on the percent of each soil type in the cell was calculated. A contour plot of the conductivity array can be found in Appendix B.

There are conceptual problems with this method since soil profiles are generally very shallow and the permeability values reported indicate the rate of downward flow rather than horizontal flow. However, the hydraulic conductivity values that were calculated were in a reasonable range for layer one. According to various hydrogeology texts (Driscoll, 1986; Todd, 1980), hydraulic conductivity in fine to silty sands, similar to layer one in Martin County, ranges from 0.03 to 32 feet/day. The model calibration improved when the soil conductivity array was substituted for the single value. Clay and hardpan layers, which are present, were not discretized into separate layers because of their discontinuous nature but are taken into account in the lower hydraulic conductivity values.

Layer Two. The transmissivity grid for layer two was developed by a two-step process. Transmissivity values obtained from numerous pump tests throughout the study area were divided

by production zone thickness to obtain hydraulic conductivities. These values were then regionalized using a kriging interpolation technique which estimates a value for each cell based on the existing information available, and the resulting array was multiplied by another regionalized array of layer thickness values from numerous drilling logs. The resulting array has a range of transmissivity from 440 ft²/day to 26,572 ft²/day. See Appendix B for a contour plot of transmissivity. The two-step process was preferred over just regionalizing pump test transmissivities because knowledge of aquifer thickness, which varies significantly, yielded a more accurate regional transmissivity array.

Layer Three. No aquifer performance tests specific to layer three were found. Therefore, the transmissivity array for this layer was created by multiplying the layer three thickness array by a constant hydraulic conductance of 20 feet/day. This resulted in transmissivity values between 200 ft²/day to 5,560 ft²/day. After sensitivity runs, better calibration in the area generally east of the Florida Turnpike was made by doubling the transmissivity value. However, in the Tequesta area, the originally calculated transmissivity calibrated better and was preserved. Contour plots of transmissivity arrays can be found in Appendix B.

Storage and Specific Yield

A single value of 9.0×10^{-4} was used for storage for layers two and three, based on the average value of pump tests performed in the study area. Repeated model runs at various storage values showed it to be relatively insensitive within the range reported from the pump tests.

Specific yield is that percentage of the total volume of water in a saturated rock that will drain by gravity and thus be available to wells. Johnson (1967) compiled specific yield values based on laboratory analysis for clastic sediments ranging from clay to coarse gravel. His findings showed specific yields for sandy clay to coarse sand ranged from 0.03 to 0.35 percent. Specific yield for layer one was set at 0.2 which represents the average value for the mostly fine sediments that comprise layer one. Subsequent testing of different values from 0.18 to 0.22 showed the model to be fairly insensitive within the range tested.

Vertical Conductivity

There is little information on the vertical hydraulic conductivity of the Surficial Aquifer System in the study area. Todd (1980) states that the

TABLE 3. SOIL TYPES AND CORRESPONDING VERTICAL HYDRAULIC CONDUCTIVITY AND CAPILLARY FRINGE HEIGHT

Soil Type	Conductivity (ft/month)	Value Used in Model		Capillary Fringe Height (feet)
		ft/month	ft/day	
Basinger	>1,200	1,400	46.7	1.0
Basinger-Ft. Drum Valkaria	360->1,200	1,400	46.7	1.0
Bessie-Okeelanta Var-Terra Ceia Var	120-1,200	360	12	1.0
Chobee-Gator	12-120	360	12	3.0
Floridana-Jupiter-Hilolo	12-1,200	360	12	1.0
Immokalee-Pompano	>380	390	13	1.0
Myakka-Basinger	>380	390	13	1.0
Myakka-Immokalee-Basinger	360->1,200	600	20	1.0
Nettles	60	60	2	1.0
Okeelanta-Canova Var Floridana	120-360	360	12	1.0
Okeelanta-Delray-Pompano	>380	390	13	1.0
Pahokee	360-1,200	780	26	1.0
Palm Beach-Canaveral-Beaches	>1,200	1,400	47	1.0
Palm Beach-Urban Land-Canaveral	>1,200	1,400	47	1.0
Pompano-Charlotte-Delray	>380	390	13	1.0
Pomello-Immokalee	360	360	12	1.0
Pineda-Riviera	360	360	12	1.0
Pineda-Riviera-Boca	360	360	12	1.0
Paola-St. Lucie	>1,200	1,400	47	1.0
Riviera	360	360	12	1.0
Riviera-Boca	360	360	12	1.0
Salerno-Jonathan-Hobe	420-900	660	22	1.0
St. Lucie-Urban Land-Paola	>1,200	1,400	47	1.0
Torry	36-120	78	3	3.0
Terra Ceia	360-1,200	780	26	1.0
Waveland-Lawnwood Basinger	12->1,200	800	27	1.0
Winder-Riviera	360-480	360	12	2.0
Wabasso-Riviera-Oldsmar	360	360	12	1.0
Winder-Tequesta	360-480	360	12	1.0
Wabasso-Winder	360	360	12	1.0

anisotropy ratio for horizontal to vertical conductivity usually falls between 2 and 10 for alluvial deposits but may range upwards of 100 if clay is present. Vertical flow in the model is a function of the vertical leakance (V_{cont}), the cell area and the head difference between layers. Values of V_{cont} were obtained by using the MODFLOW calculation for vertically adjacent geohydrologic units which is as follows:

$$\frac{1}{\text{Thickness of upper layer}/2 + \text{Thickness of lower layer}/2} = \frac{1}{(\text{Hydr. K upper layer})^{*}.1 + (\text{Hydr. K lower layer})^{*}.1}$$

For this model, a $k_{vertical}/k_{horizontal}$ anisotropy ratio of 0.1 was assumed for all zones in the aquifer. In the Jensen Beach Peninsula model (Hopkins, 1991), repeated calibration runs resulted in vertical conductance values of approximately a quarter of those estimated using the 0.1 anisotropy figure between layers one and two, apparently due to vertical impedance to flow caused by fine sands and clay layers at the base of layer one. This situation also occurs within this model area and calibration runs indicated a minor improvement in isolated areas in the eastern portion of the county with a lower anisotropy ratio. However, it was difficult to delineate and justify the lower anisotropy areas. Additional research and further refinements to the model on this subject should be addressed in future versions of the model. Clay lenses, which are present, but not well defined in the aquifer, were not represented explicitly in the model since their discontinuous nature gives them a local rather than regional influence.

SURFACE WATER INTERACTIONS

Canals, rivers and lakes were represented in the model using either the drain, river or general head boundary packages. The general head boundary package was used to represent water bodies along the model boundaries, as previously discussed in the boundary condition section. It was also used to represent the Florida Power and Light (FP&L) reservoir. The river package was used to represent all other controlled canals and those canals with frequent water level data. Uncontrolled canals were represented as drains. The location of river and drain cells in the model can be found in Figure 11. Appendix C summarizes the widths, control structure elevations, bottom elevations and multipliers used for the river and drain reaches.

The river package represents each river/canal reach as a source of water outside the aquifer with a conductance to the aquifer based on river/canal

length, width or wetted perimeter, sediment thickness and sediment hydraulic conductivity within each model cell. Flow between the river and the aquifer is determined by the head difference existing between the river reach and the model cell containing it and is proportional to the conductance. Heads in the river reaches are set to the river/canal maintained level or measured water level collected by the SFWMD and the USGS. Flow direction may be either from the river reaches to the aquifer or vice versa, depending on the direction of the head gradient. Thus, river cells may serve as either a source or sink of water with respect to the aquifer with both flow volume and direction varying according to the head gradients.

The drain package simulates flow in one direction only, from the aquifer to the drain, while both the general head and river packages simulate flow either into or out of the aquifer. The drain conductances are calculated in the same manner as the river and general head conductances. Flow into the drains occurs when the simulated aquifer head is greater than the specified drain elevation. The flow is proportional to the conductance and the difference between the aquifer head and the drain elevation. When the elevation of the drain is greater than the aquifer head, no flow occurs. Drains were used in the model to represent canals where water levels are not maintained at specified heads. The drain elevations were usually set to the control structure elevation. If the structure elevation was lower than the canal bottom elevation or there was no control structure, the canal bottom elevation was used for the drain elevation (see Figure 12).

The conductance term is used to represent the stream-aquifer interconnection, which is affected by streambed material. River and drain conductances for a cell were obtained by the following calculation and are illustrated in Figure 12:

$$\frac{KLW * \text{multiplier}}{1'} \quad (5)$$

where

$$\begin{aligned} W &= \text{width of reach} \\ L &= \text{length of reach} \\ K &= \text{layer one conductivity} \end{aligned}$$

The 1 foot value represents canal bed thickness. The multiplier was used as a calibrating tool since streambed material data are extremely limited, and was determined from numerous model runs. For river reaches, the multiplier ranged from 0.001 to 0.01, with the Intracoastal and tidal rivers generally

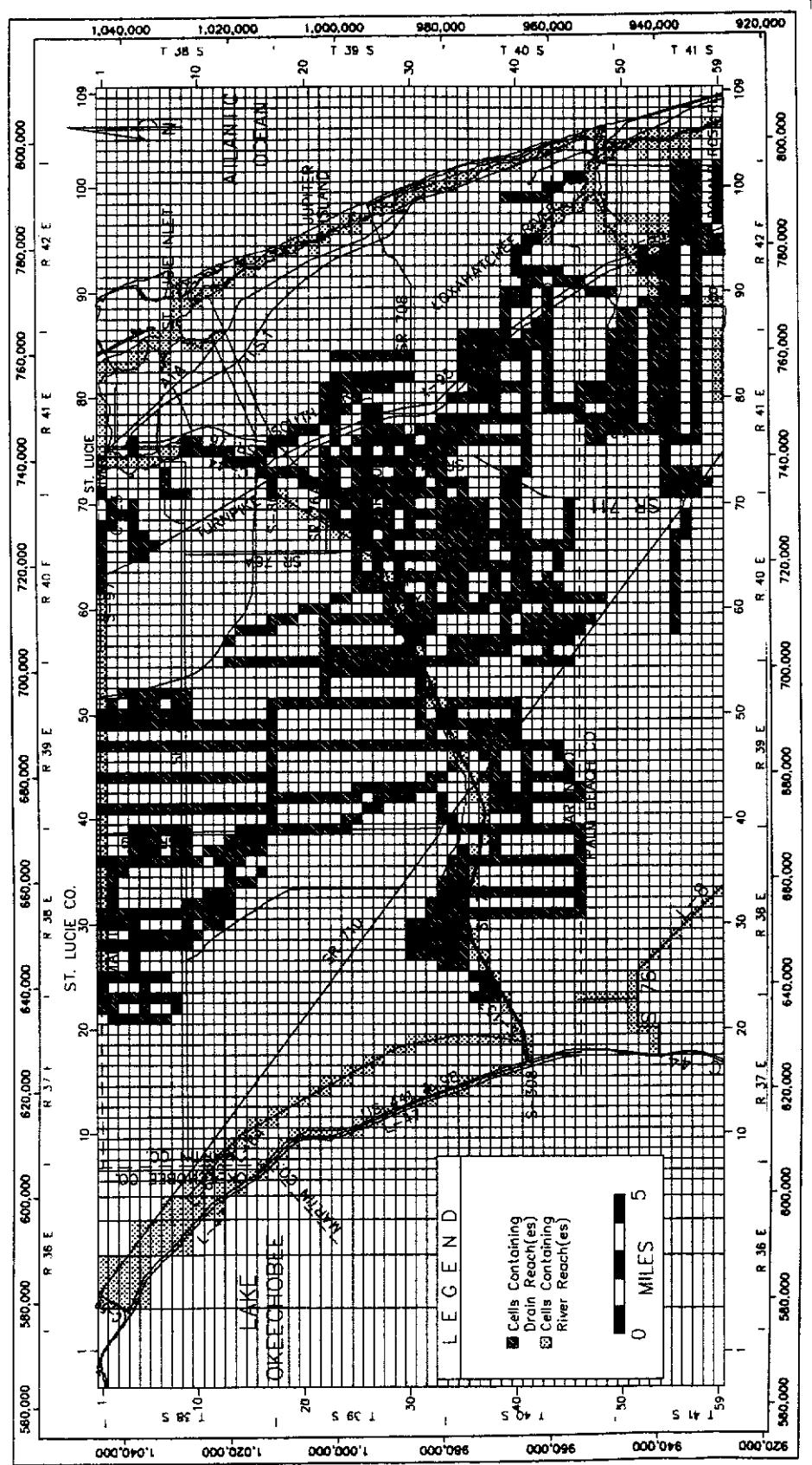
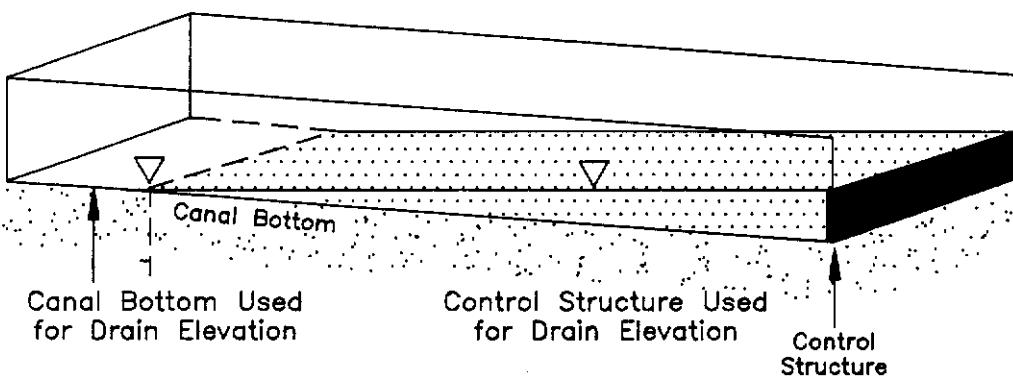


FIGURE 11. Cells Containing River and Drain Reaches

Drain Elevation Determination



$$\text{River/Drain Conductance} = \frac{K L W}{M}$$

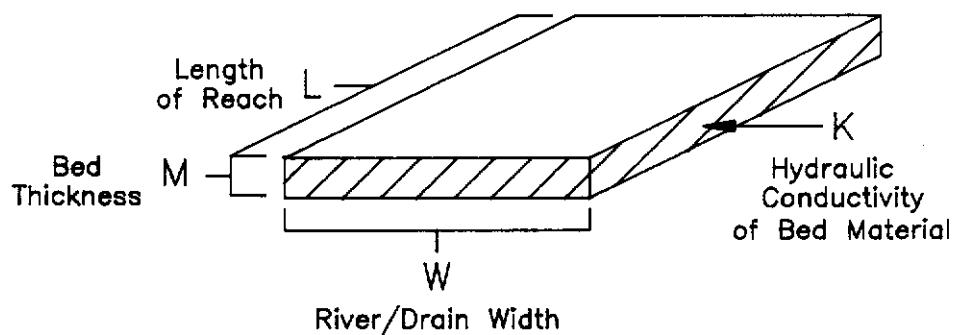


FIGURE 12. River and Drain Conceptualization

requiring a multiplier of 0.001. The drain reach multipliers ranged from 0.001 to 0.1, with most grove canals requiring a multiplier of 0.01.

The length of river and drain reaches was measured from USGS topographic maps, overlain with the model grid. The width of river reaches was determined from USGS maps, permit maps, canal survey maps or "as-built" drawings by the Corps of Engineers. When available, the same sources were used for drain reaches, however, widths for most grove canals were estimated based on discussions with the land owners or their engineering consultant.

The Florida Power & Light reservoir is a large water body within the modeled area with stages that fluctuate within a small range. It is an above-ground reservoir; therefore, there is some lithologic restriction to flow between the reservoir and the underlying water table. The general head package was used to simulate the reservoir. Conductance terms were calculated in the same manner as those for river bottom conductances (Equation 5). The multiplier was varied until modeled leakage values were similar to values reported by FP&L. The FP&L reservoir calibrated conductance calculation is as follows:

$$\frac{KLW}{2} * .001 \quad (6)$$

where,

K = layer one horizontal hydraulic conductivity for that cell

L = row length

W = column width

RECHARGE

Rainfall recharges the Surficial Aquifer System over its entire area. Average annual rainfall ranges from 50 to 60 inches in the study area (MacVicar, 1983). Most of this rain, 38 to 44 inches on average, falls during the wet season from May through October. Average rainfall during the dry season, November through April, is approximately 12 to 16 inches. Wet and dry season durations may vary from year to year.

For the modeled time period, annual rainfall (amounts observed in any consecutive 12-month period) steadily declined from normal to record below-normal amounts from August 1988 until August 1989 after which it moderated but stayed below normal well into 1990 (Trimble, et al., 1990).

For 1989, average annual rainfall from stations in the study area was 44 inches, ranging from 24 to 57 inches for individual stations. Wet season rainfall ranged from 12 to 43 inches, averaging 31 inches and dry season rainfall amounts ranged from 9 to 21 inches, averaging 14 inches.

Rainfall events in south Florida are often localized, particularly in the summer months when convective thunderstorms are common. Frequently, these events are very intense and of short duration. In winter months, however, frontal systems and occasional tropical depressions (hurricanes) provide more evenly distributed rainfall over the study area. Because of the variable nature of most rain events, there are an inadequate number of rain stations to provide a completely accurate distribution of rainfall. Daily rainfall data collected from 41 stations were used in creating the recharge arrays. Appendix D includes information on each station as well as a station location map.

Recharge is calculated as a function of interception, depression storage loss, and surface drainage.

The following summarizes the preprocessing steps taken to create the recharge arrays:

- 1) assembled daily rainfall totals from numerous stations throughout the study area collected by federal and state agencies, grove operators, utility operators and golf courses;
- 2) assuming one precipitation event per rainy day, 0.11 inches from that event was removed and summed for each month as depression storage;
- 3) the monthly depression storage is subtracted from the monthly total rainfall and the remaining recharge was contoured using the inverse distance method to determine a value for each model cell;
- 4) the resulting arrays were further reduced to remove interception water based on land use type, runoff to surface drainage based on slope, and hydraulic conductivity of the soil (see Figure 13 for land use types in the model area; the calculations for interception and runoff can be found in Appendix D);
- 5) added to the final recharge arrays was 50 percent of the irrigation water withdrawn by flood irrigated agricultural operations in the appropriate cells.

**General Land Use Level 1
1986-88 Data**



FIGURE 13. Land Use Types in Study Area

For a detailed discussion of the recharge calculations, please refer to Appendix D.

The flood irrigation recharge figure is based on assumptions made in the SFWMD Water Use Permit Information Manual (SFWMD, 1985) that in flood irrigated projects 50 percent of the water applied is used by the crop. To be consistent, all irrigation projects that are not 100 percent efficient should return some water as recharge to the first layer of the model. Due to current limitations, it was too difficult to calculate the contribution to each model cell for each irrigation project; therefore, only the flood irrigated projects were included. Figure 14 illustrates the model cells to which irrigation recharge was added.

The net recharge, after all subtractions from rainfall have been made, for a single steady state month is shown in Figure 15. Because of the number of variables involved in determining what portion of rainfall would actually recharge the aquifer, the ratio of rainfall to recharge varies widely throughout the county (Figure 16). However, a check of the ratio for broad land use types in the month with the least (February) and most (August) rainfall in 1989 provides some information. In February, the average calculated rainfall/recharge ratio for urban areas was 41 percent; for agricultural areas, 43 percent; for forested areas, 51 percent; and for wetland areas, 48 percent. In August, the ratios were 53 percent for urban, 59 percent for agricultural, 62 percent for forested and 62 percent of rainfall for wetlands. As mentioned previously, these are averages and the ratio for any given cell and land use type ranges from zero to 98 percent of rainfall based on the many variables included in the determination.

The recharge term used in MODFLOW represents water that actually reaches the aquifer. In areas where there is a significant unsaturated zone above the water table, the above recharge calculations become inaccurate. An additional portion of the calculated recharge never reaches the aquifer because of the large soil storage capacity in the unsaturated zone. Dune area plants will satisfy their water needs from the soil water and never use water from the aquifer itself. Therefore, in cells where there was 16 to 20 feet of unsaturated soil, recharge to the aquifer was reduced by half, and in cells with unsaturated zones of 20 feet or more, recharge was reduced to zero, which improved calibration. The recharge reduction figures, based on thickness of the unsaturated zone, were not based on specific scientific data, but on calibration results. A scientific approach for more exact determination of

the recharge prevented from reaching the aquifer by a significant unsaturated zone above should be examined. Figure 14 illustrates the model cells in which recharge was altered.

EVAPOTRANSPIRATION

Evapotranspiration (ET), water loss through evaporation and plant transpiration, is the largest mechanism for ground water loss from the system. ET is a complicated process controlled primarily by weather, vegetation, soils, and water availability. There are numerous methods available to estimate ET using different combinations of factors. The modified Blaney-Criddle method was used in this model to estimate the potential evapotranspiration rate.

The modified Blaney-Criddle method is based on the principle that ET is proportional to the product of day length percentage and mean air temperature and incorporates crop type as it relates to the ET estimate for grass (Jensen, 1980).

Water loss from the saturated ground water regime through direct evaporation and through transpiration from the saturated zone by plants is simulated in the model by the Evapotranspiration (ET) Package of MODFLOW. The following assumptions are applied (McDonald and Harbaugh, 1988):

- 1) When the water table is at or above a specified elevation, termed "ET surface", ET loss from the water table occurs at a specified maximum rate.
- 2) When the water table elevation drops below a specified value, termed the "extinction depth" or "root zone", ET from the water table ceases.
- 3) ET from the aquifer varies linearly between the above limits.

The evapotranspiration from the unsaturated zone is not considered at this point but modifications to the code are currently under development at SFWMD.

The ET surface elevation is represented in the model by the average land surface elevation in each cell minus the capillary zone height for that cell (see Figure 17 for conceptualization). Land surface values were taken from USGS 7.5 minute topographic quadrangle maps. Because of the model cell sizes, there is only one elevation for each 2,000 by 2,000 foot area and it represents the average elevation within that cell. In most areas, there was

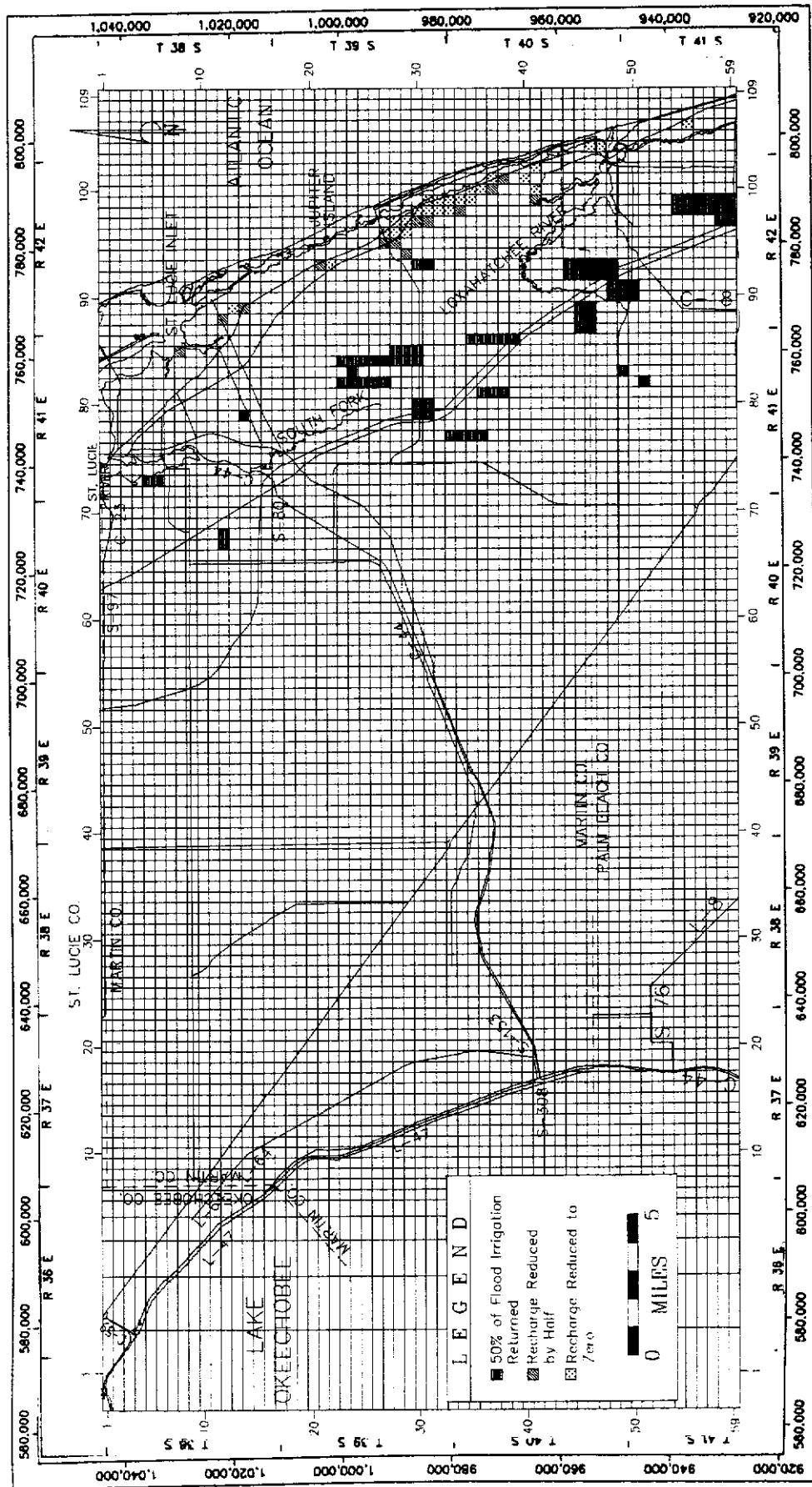


FIGURE 14. Cells with Modifications to Recharge Array

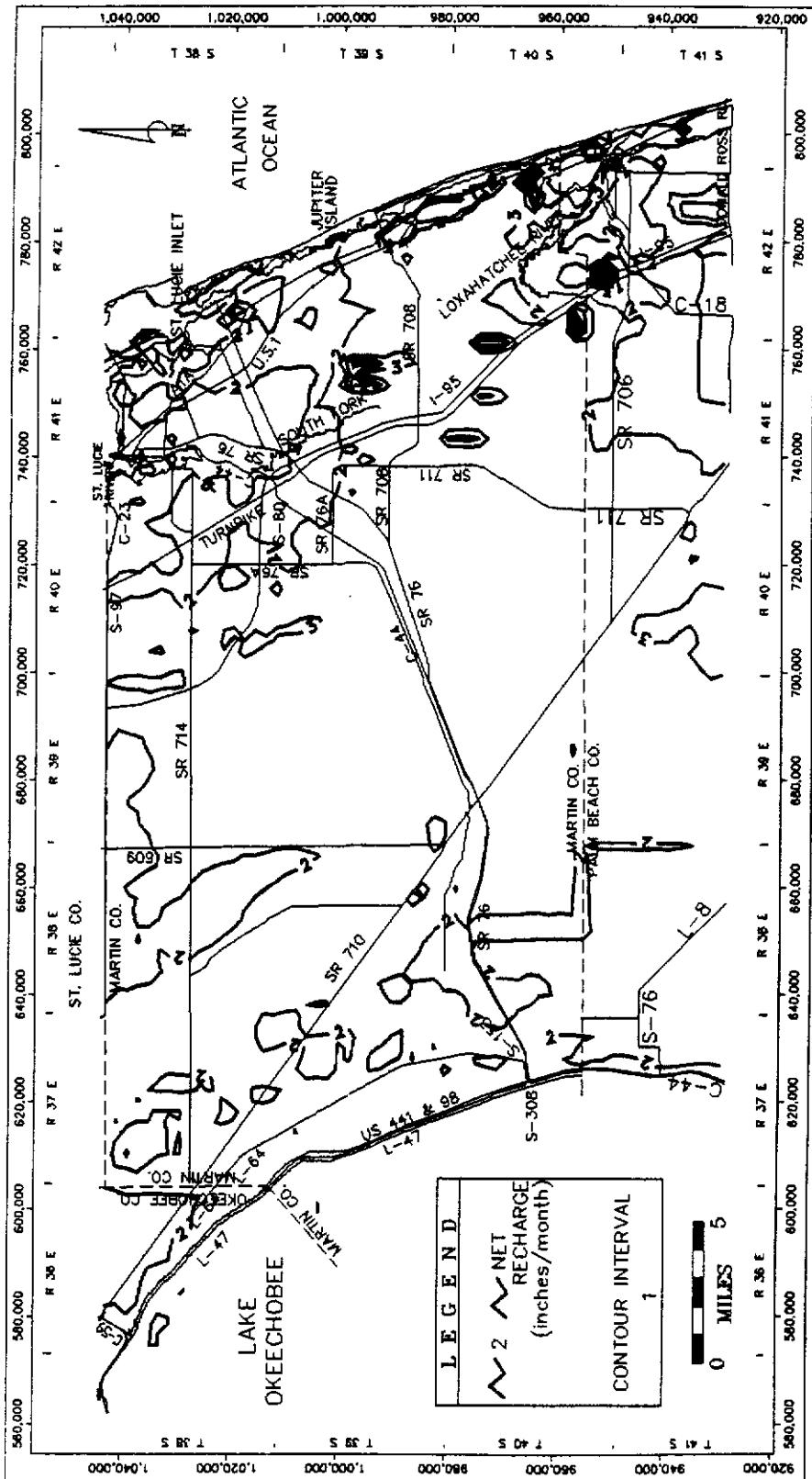


FIGURE 15. Net Recharge, Steady State

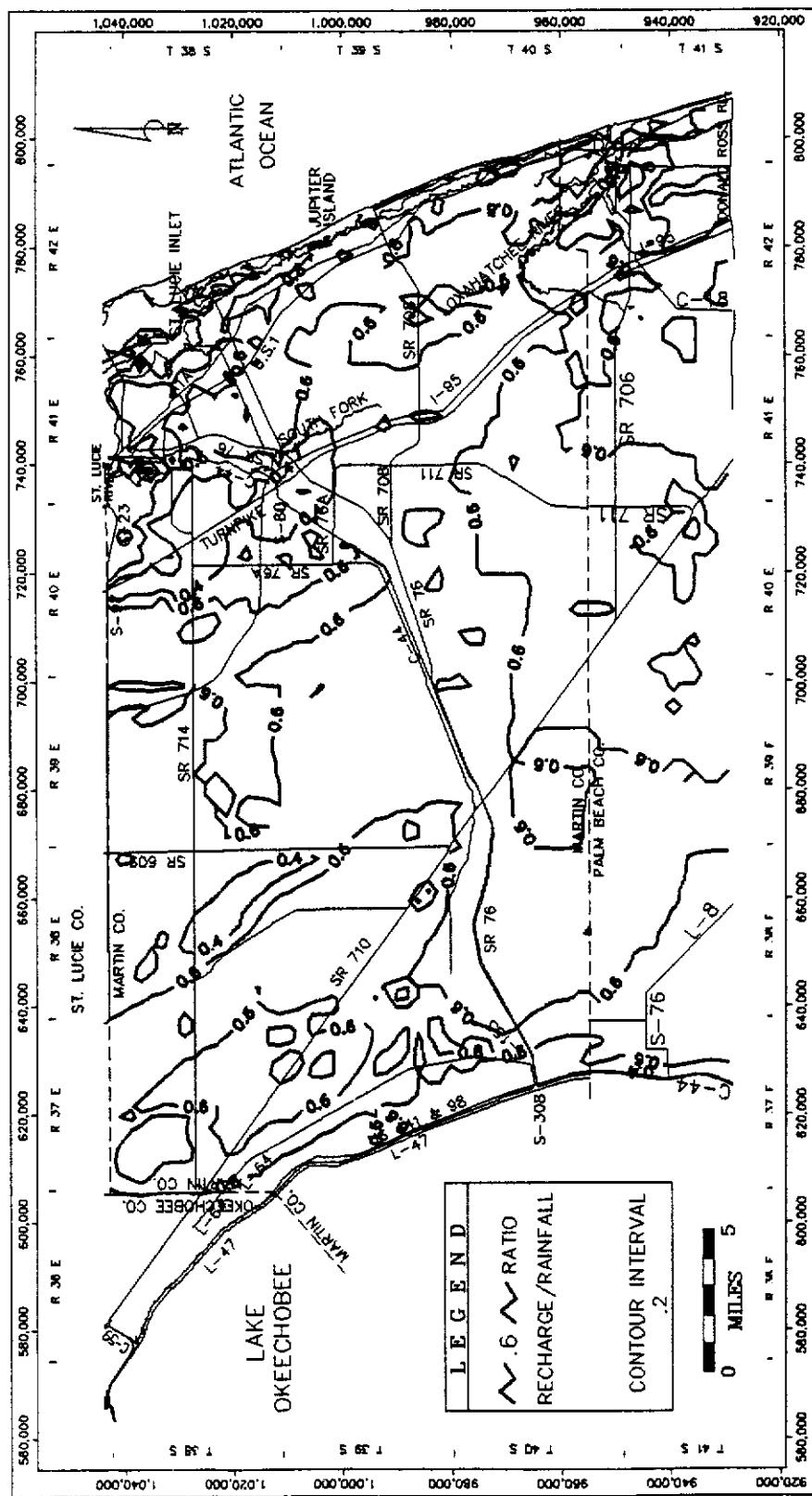


FIGURE 16. Ratio of Net Recharge to Total Rainfall, Steady State

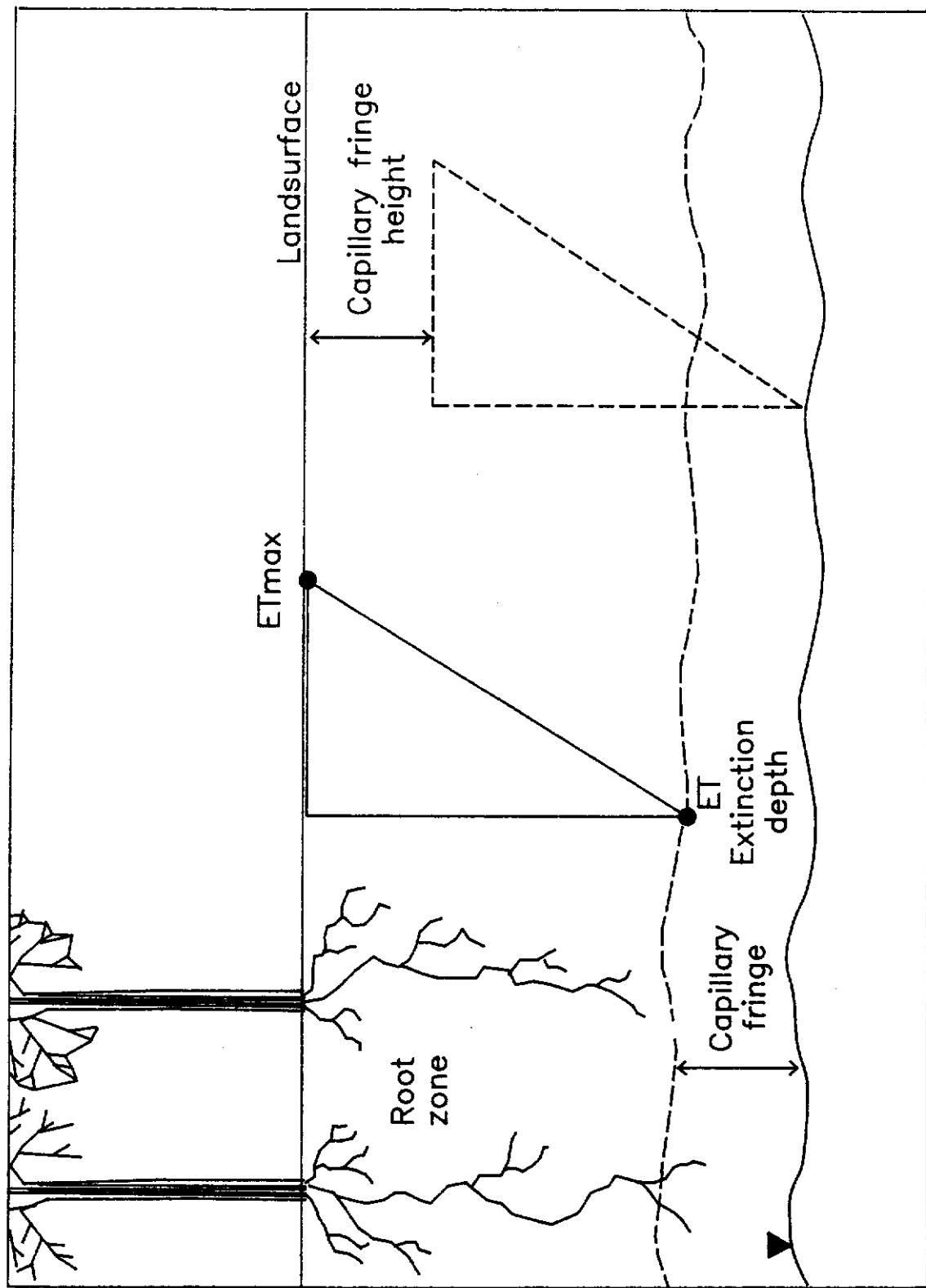


FIGURE 17. Conceptualization of Capillary Fringe and ET Extinction Depth Determination

only a one or two foot difference in elevation within a cell. However, in some areas, the elevations changed as much as 20 feet within a cell and the average value will not represent conditions throughout the entire cell. The consequences of land surface averaging is discussed in the calibration section. The ET surface was then altered ± 2.5 feet for specific cells during the calibration process.

Capillary rise is a function of soil grain size and can vary from 0.38 centimeters in a coarse gravel to 3 meters in clay (Fetter, 1980). Noting the sandy, clayey soils in the modeled area, it was assumed that a significant volume of water would be lost by ET in the capillary fringe. Since MODFLOW does not address ET that occurs when the water table drops below the root zone, capillary fringe ET was approximated by reducing the original ET surface (land surface) by an amount equal to the capillary fringe height. The height (Table 3) was determined by soil type, and an array of capillary fringe heights was created. To be physically accurate, the capillary zone height should be added to the water table level, however, since the water table changes with time, this raising of the available water level would need to be incorporated in the MODFLOW program. A simplifying assumption was adopted for calculation purposes by moving the ET "window" down by an amount equal to the capillary zone height.

Where water bodies were present, the free water surface evapotranspiration rate was used. For all other areas, the maximum ET rate was estimated using the modified Blaney-Criddle equation. The basic form of the equation is:

$$U = k k_t \frac{P_m t_m}{100} \quad (7)$$

where,

U is the crop ET for a given month, in inches per day from layer 1,

k is a consumptive use coefficient which varies according to the crop, type and growth stage,

k_t is a climatic coefficient which is related to the mean air temperature;

$k_t = .0173t - .314$, where t is Fahrenheit temperature,

P_m is the percent of daytime hours of the year which occurred during the month,

t_m is the mean temperature for the month, in degrees Fahrenheit.

The consumptive use coefficient is defined:

$$k = k_c * k_f \quad (8)$$

where,

k_c is a coefficient reflecting the growth state of the crop (Table D-4, Appendix D), and

k_f is a coefficient reflecting the fraction of land surface which is covered with a specific type of vegetation (also Table D-4) it varies between 0.1 and 1.0.

Temperature data was used from stations in Stuart, Jupiter and Indiantown. Crop coefficients (k_c) were either taken directly from or inferred from values presented in SFWMD's Permit Information Manual Volume III (SFWMD, 1985). Values of k_f for urban land uses were determined by examination of surface water permit data for ratios of pervious to impervious area.

Extinction depth physically represents the depth to which the roots of plants extend below land surface and is determined in MODFLOW as the depth of the water table below the ET surface elevation beyond which evapotranspiration ceases. Extinction depths in the model are related to land use and are based on estimated root depth for various kinds of vegetation supplied by the District's Planning Department (Teets, 1990, personal communication). A table with values used can be found in Appendix D.

The MODFLOW evapotranspiration package removes water from the aquifer up to the maximum ET rate specified. If the aquifer head is below the root zone extinction depth, the model does not remove any ET. In groves, for example, drainage canals are designed to keep the root zone drained. Consequently, the model does not remove any water from the aquifer to ET in most grove canals. This is a valid approximation since the water removed by evapotranspiration in a grove is mostly provided by drip irrigation rather than from the aquifer itself. In dune areas also, the aquifer head is significantly lower than the root zone extinction depth, so no ET water is removed from the aquifer. However, as discussed above in the recharge section, these dune plants do transpire using recharge water retained as soil moisture which then never reaches the aquifer. These are all examples of situations which preclude the use of reported evaporation data without significant alteration. It becomes apparent that MODFLOW currently is not capable of a full accounting of all recharge and evapotranspiration taking place and users should be aware of the

limitations and adjustments that should be made to input data sets.

GROUND WATER USE

Water use figures for the model were determined using data from water use permits issued by the SFWMD. Individual water use permits are required if the average daily water use equals or exceeds 100,000 gallons per day (gpd). An individual water use permit is also required of smaller uses (average daily use exceeding 10,000 gpd) in Reduced Threshold Areas (RTA). The Stuart and Lighthouse Point (north of Palm City) areas are designated RTA's (Figure 2). The SFWMD also issues general water use permits to all uses less than 100,000 gallons per day, with the exception of single family homes, duplexes, and water used strictly for fire-fighting (SFWMD, 1985).

General water use permits were included in the determination of water use for the model because the total amount covered in general permits could be significant considering the hydraulic conductivity of the aquifer. All legal uses of water, no matter how small, are important from a management standpoint because they are protected by the District's water use rules from adverse impacts caused by other water users. Therefore, impacts to the smaller users can affect larger users, requiring reduced withdrawals or mitigation of the adverse impacts. This can be of critical importance during the management of competing uses.

The permits were used to determine withdrawal facilities, water use type, project size and project location. The permit allocation was not used in the model, as it does not necessarily equal the actual use. For example, in public water supply permits, the allocation covers a ten year period during which pumpage increases gradually with increasing population. In agricultural areas, some facilities and planted acreage may be proposed and not installed during the model period. Therefore, wherever possible, actual use was input to the model, and all estimated uses were based only on existing facilities and planted acreage.

Agricultural

Agricultural water use accounts for 27 percent of the ground water well withdrawals in the model. This category includes all farming, golf, recreational, landscaping and nursery uses. Records of water withdrawn for agricultural uses are submitted to the SFWMD for a small percentage of the projects. Where these records were available, the information was input directly into the model. Where sufficient

information was not available, irrigation application rates were estimated. The irrigation water requirements of different crops was estimated using a method described by the U.S. Soil Conservation Service (USDA, 1970). This method uses the modified Blaney-Criddle formula to estimate the water requirements of various crops. Crop type, soil type, air temperature, daylight hours, effective rainfall, and irrigation system efficiency are used to calculate the irrigation requirements of different crops found throughout the modeled area.

Data on all agricultural water uses with individual and general water use permits was assembled into a spreadsheet. This information included crop types, acreage, irrigation system data, well information, and soil types. Precipitation data from the closest station (Stuart, Indiantown or Jupiter) was used to determine effective rainfall. The irrigation requirements for each permitted use were estimated for each month of the calibration period (January 1989 through December 1989). The monthly irrigation requirement for each permitted use was distributed among the permitted withdrawal facilities in proportion to their pump capacities. Individual wells were then assigned to the proper model cell.

Fourteen landscape irrigation permits that report pumpage to the SFWMD were compared to the modified Blaney-Criddle estimates for each project. On average, Blaney-Criddle overestimated irrigation requirements in April through August and underestimated in October through March, estimating only half of what was actually being pumped by users in January and February. The Blaney-Criddle supplemental crop requirements were adjusted according to these findings (Table 4) and these adjusted requirements were used for all landscape irrigation uses where actual pumpage was not available.

Several crop types were either not included or only reported pumpages were used, rather than Blaney-Criddle estimates. Withdrawals from surface water sources were not considered. Pasture allocations were not included because they are generally irrigated from surface water sources and since runoff water is usually held in pasture ditches by control structures, supplemental water is rarely needed. The Blaney-Criddle formula is difficult to use for nursery irrigation requirements, therefore, all nurseries were contacted and actual irrigation practices were used to estimate withdrawals. The one large citrus grove in Martin County which uses surficial aquifer water for irrigation maintains pumpage records, which were incorporated in the

**TABLE 4. SUPPLEMENTAL IRRIGATION WATER RATES USED TO CALCULATE
IRRIGATION OF GRASS (Inches/Month)**

STUART

Soil#*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
.4	2.40	2.54	4.15	2.52	3.50	3.38	3.83	2.55	3.01	3.27	2.98	2.14
.8	2.09	2.25	3.85	2.38	3.26	3.00	3.47	2.33	2.43	2.41	2.79	1.95
1.5	1.64	1.84	3.43	2.18	2.93	2.45	2.95	2.01	1.58	1.19	2.53	1.65

JUPITER

Soil#*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
.4	1.71	2.75	4.08	2.64	3.22	3.47	3.90	2.45	3.07	2.03	2.55	2.38
.8	1.25	2.46	3.75	2.52	2.97	3.13	3.58	2.22	2.47	0.97	2.30	2.16
1.5	0.59	2.03	3.30	2.34	2.61	2.63	3.11	1.89	1.62	0.50	1.95	1.84

INDIANTOWN

Soil#*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
.8	1.95	1.59	3.44	1.93	3.28	1.81	3.22	1.94	2.97	3.92	2.73	2.14

ADJUSTMENT FACTOR - 1989 records from 14-19 permits.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
multipl.	2.35	2.05	1.64	0.67	0.77	0.81	0.80	0.54	1.12	1.86	1.33	1.60

Calculation: Supplemental irrigation rate * irrigated acres/irrigated system efficiency

*Soil # maps for each county in the SFWMD can be found in Permit Information Manual Volume III

model. Almost all other groves primarily use surface water with Floridan Aquifer augmentation in a few groves. All small vegetable growers were also contacted and actual irrigation practices were used to estimate irrigation withdrawals. For uses not currently permitted by the SFWMD but visible on USGS quad maps, the owners were contacted for facility information which was then incorporated into the model.

Agricultural water use data is presented in Appendix E. Figures 18 and 19 show the distribution of cells with well withdrawals for layers one and two, respectively. Layer three did not contain any well withdrawals.

Public Supply

Public water supply (PWS) withdrawals account for 24 percent of the total modeled ground water well withdrawals. Ground water withdrawals for PWS were obtained from pumpage information routinely furnished to the Florida Department of Environmental Regulation (FDER) by the water utilities. These reports provide total raw water pumpage for the entire wellfield. Since many wellfields in Martin County are distributed over several model cells, individual well discharges were used whenever possible. If there were multiple wells in a wellfield and individual well pumpages were not available, total pumpage was divided among the wells based on the individual well capacities of routinely active wells. Model cells containing public supply withdrawals are shown in Figure 20. The location of PWS wells used in the model, along with information on withdrawals, can be found in Appendix E.

Domestic Self-Supply

Domestic self supply accounts for 45 percent of modeled ground water well withdrawals. This withdrawal type covers all non-potable (outdoor) and potable (indoor) water use not supplied by a utility. While potable uses are fairly well documented, there is a lack of data in the area of non-potable water use, because the majority of non-potable water is self supplied and pumpage records are not maintained for the majority of private wells being used for irrigation (Opalat, 1985). In developing an urban water demand model for Martin County, Opalat, 1985, describes a method of determining residential non-potable demand. The methodology involves developing figures for each land use type taking into consideration allowable unit density, percentage of units having automatic irrigation systems, and irrigation application rates and frequency. Model

cells containing urban land use types, and therefore having the potential for domestic self-supply withdrawals, are shown in Figure 21. Table 5 summarizes the assumptions made for each urban land use type. Land use information collected in 1986-1988 was used and no adjustments for partial buildout were made.

Once the locations of different urban land use types were determined, the areas were further subdivided into large utility supplied, small utility supplied and self supplied (Figure 21). Types of water use were broken into three categories: irrigation by automatic sprinkler system, irrigation by hand watering (garden hose), and indoor water use. In areas where water is utility supplied, any hand watering was assumed to come from the utility water.

Model results indicate that potable demand breaks down to 32 percent from large utilities, three percent from small utilities and 64 percent self supplied. A figure of 120 gallons per capita per day was used in the potable demand estimates. This figure is based on water use information published in the 1983 City/County Data Book (USDC, 1983).

It was assumed that all non-potable water use not supplied by a utility came from ground water wells rather than canals. This assumption is based on the fact that there are very few fresh water canals in urban areas of Martin County and coastal Palm Beach County. The Jupiter Farms area in Palm Beach County does have a fresh water canal system but all the houses have wells for drinking water so it was assumed that irrigation water would also come from these wells. In addition, the lots are large in Jupiter Farms and houses may be a considerable distance from the canals.

The irrigation figures resulting from the land use method then were compared to irrigation demand using the modified Blaney-Criddle calculation for the same acreage of grass. The land use method estimated water use to be 1.6 times what Blaney-Criddle determined to be necessary. However, as discussed earlier in the agricultural water use section, reported figures for grass irrigation indicate that Blaney-Criddle is not entirely accurate. Reported actual use on an annual basis for large-scale landscape irrigation was found to be an average of 1.3 times what Blaney-Criddle calculated. This would indicate that the land use method of determining self-supply is acceptable.

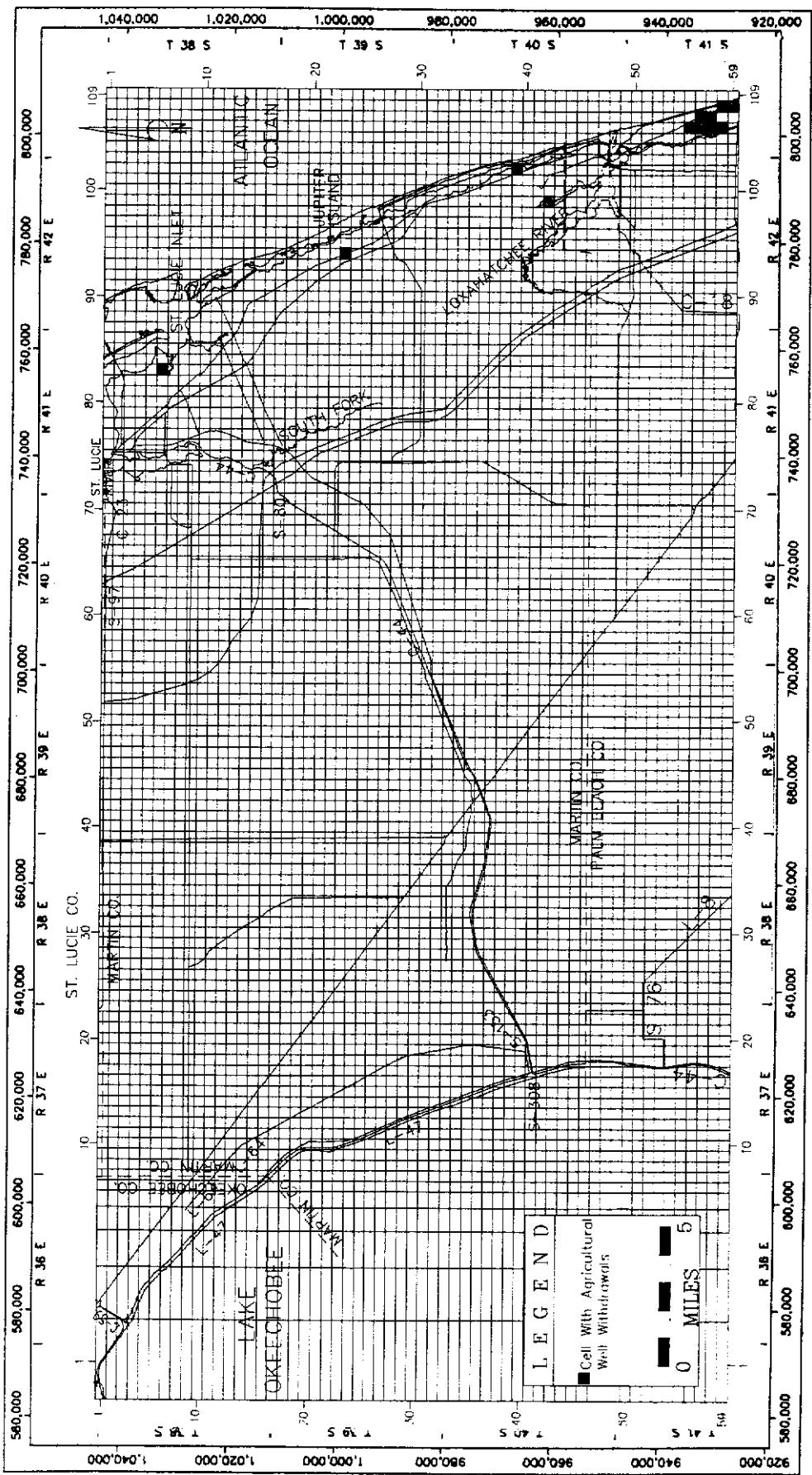


FIGURE 18. Cells Containing Agricultural or Industrial Wells, Layer 1

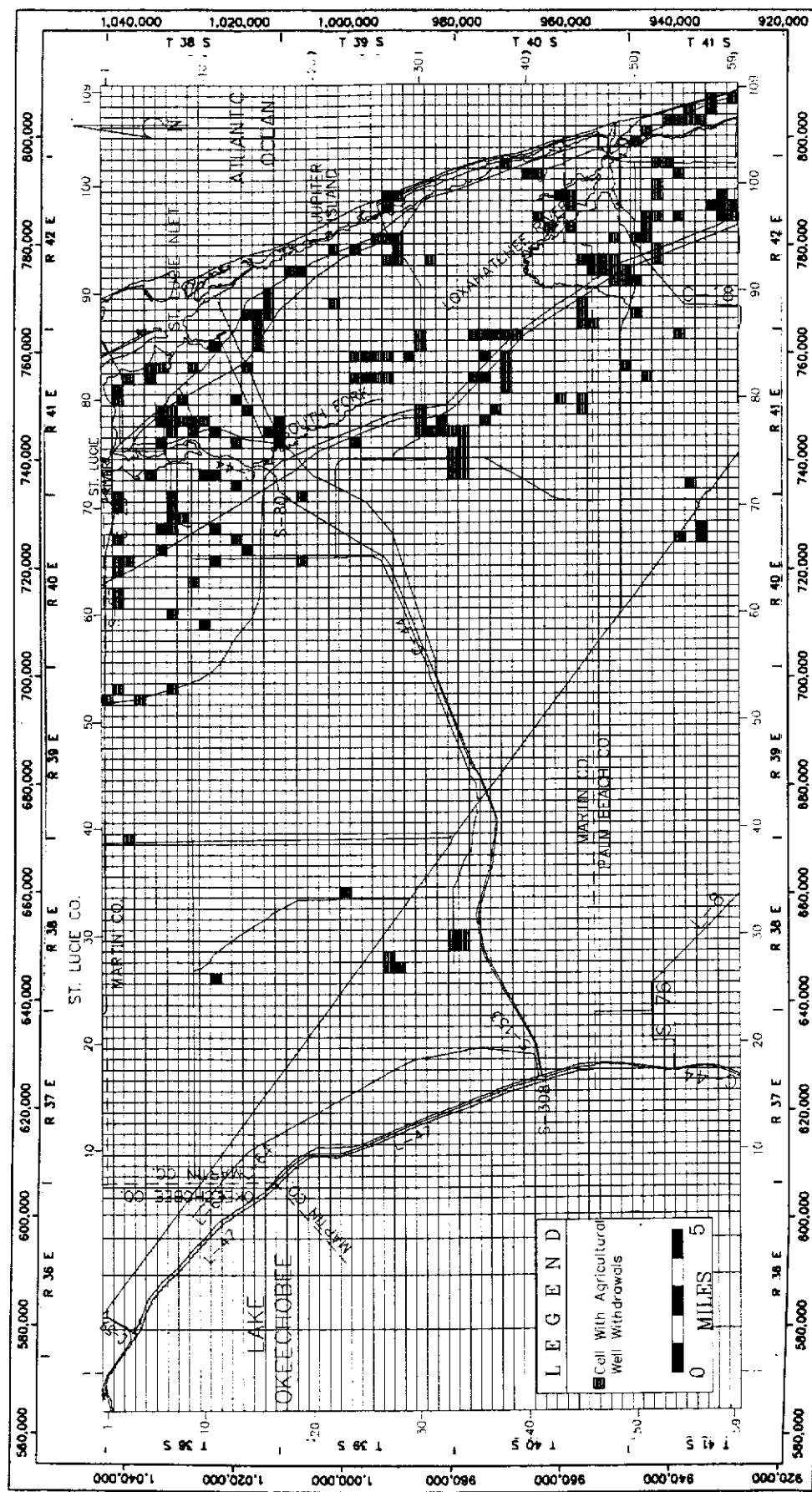


FIGURE 19. Cells Containing Agricultural or Industrial Wells, Layer 2

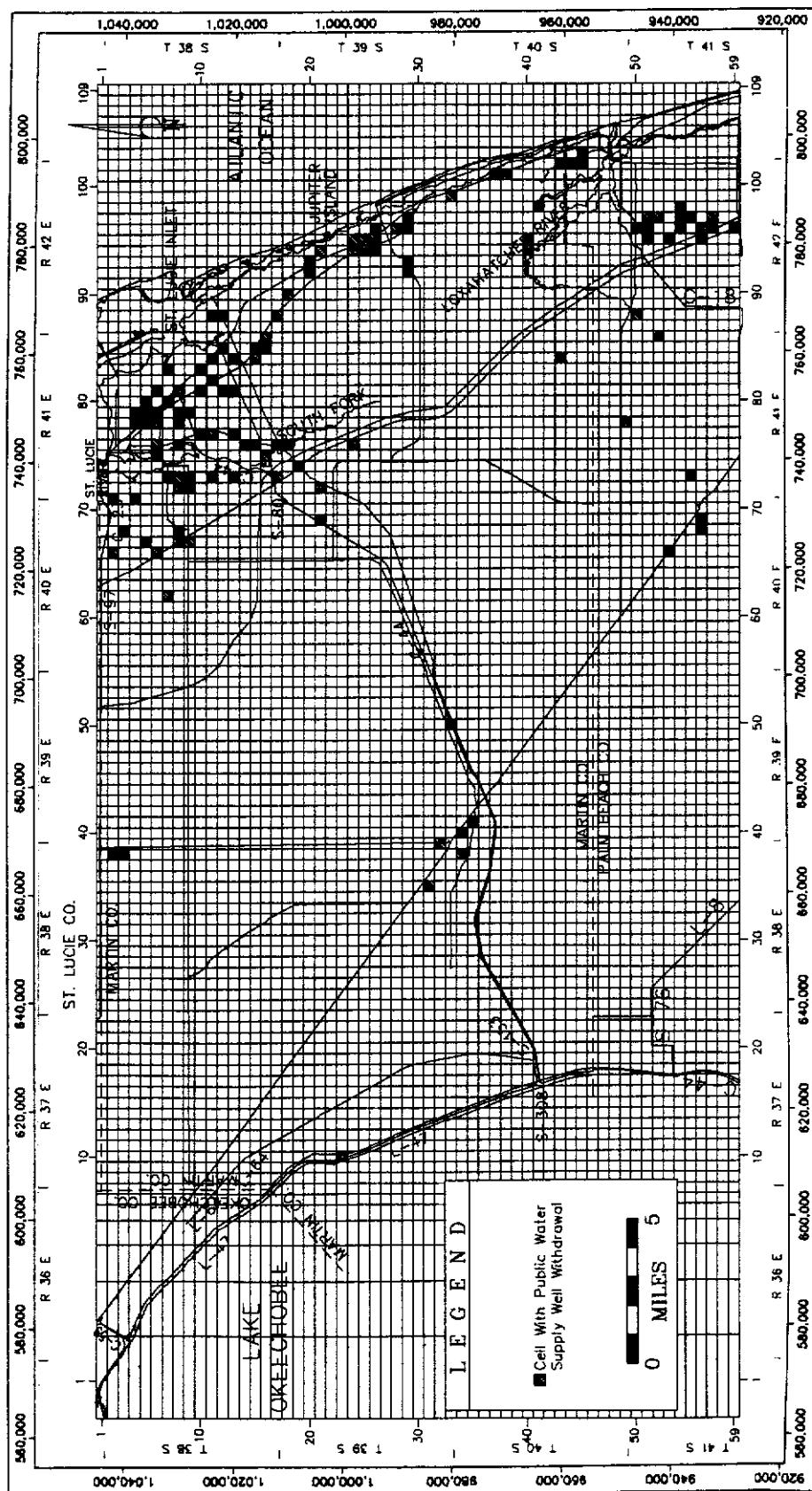


FIGURE 20. Cells Containing Public Water Supply Utility Wells

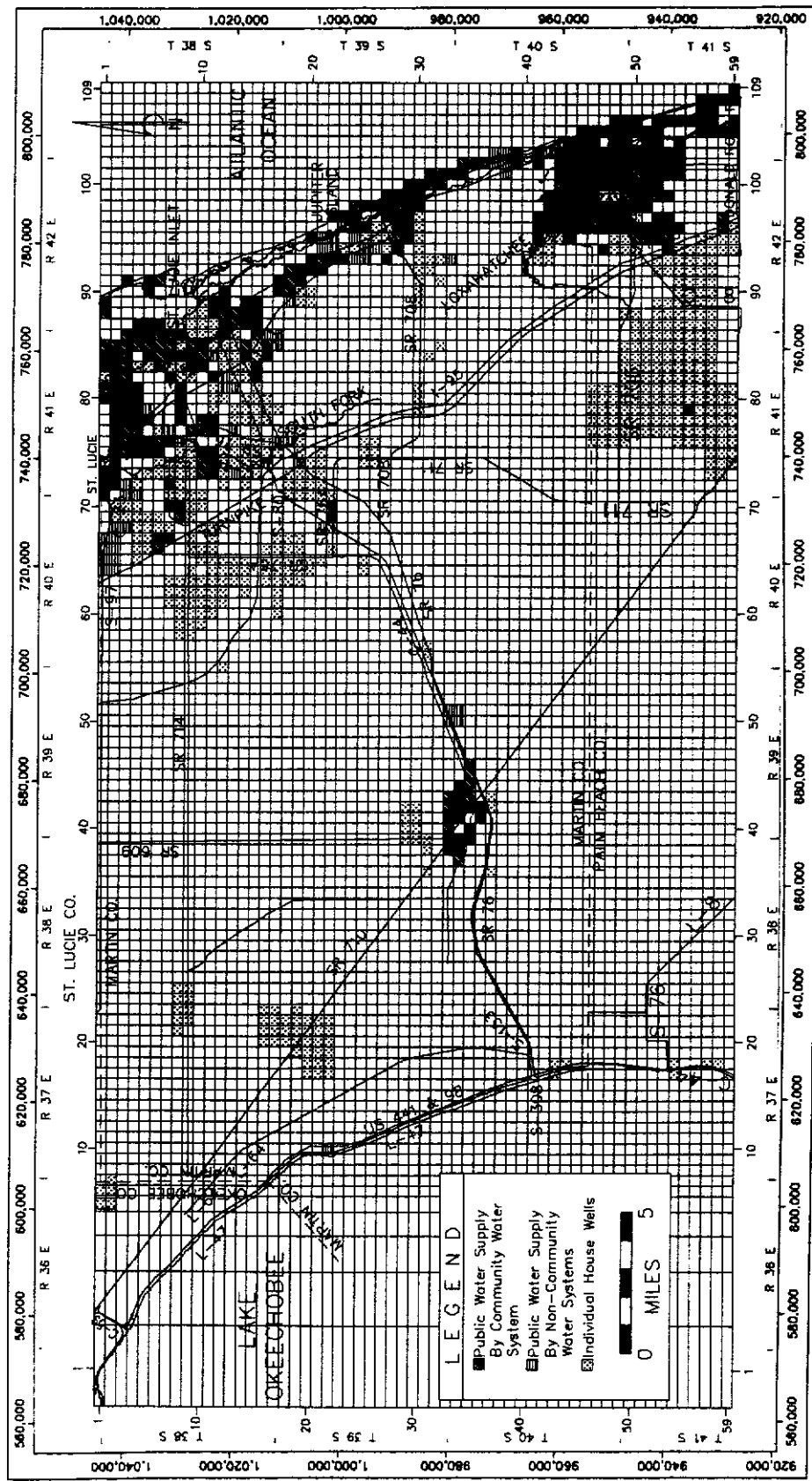


FIGURE 21. Urban Land Use Cells Served by Large/Small/No Utility

TABLE 5. DOMESTIC SELF-SUPPLY ESTIMATE PARAMETERS

<u>Land Use Type</u>	<u>Single Low</u>	<u>Single Med</u>	<u>Single High</u>	<u>Multi-family</u>	<u>Mobile Homes</u>
Acres Irrig	.5	.23	.11	.03	.02
Sprinkl Units	.5	.75	.50	.75	.25
Capita/Acre	.84	8.4	19.2	36	19.2
D.U./Acre	.35	3.5	8	15	8

Assumptions:

Drinking water -

120 gpcd (1983 City/County Data Book)

Irrigation rate -

Sprinkler systems: 3/8" per acre X 3 times/week X 4 weeks per month

Hand watering: 1/4" per acre X 3 times/week X 4 weeks per month

All sprinkler systems use private wells

Formulas:

Drinking water:

Acres of land use type * capita per acre * 3600 gpc/m)

Irrigation:

Sprinkler systems: Acres of land use type * # of dwelling units * % of units with
sprinklers * acres irrigated per unit * 135762 gallons/acre/month

Hand watering: Acres of land use type * # of dwelling units * (1 - % of units with
sprinkler systems) * .5 * acres irrigated per unit * 67881 gal/acre/month

Other Ground Water Uses

Most of the other uses of ground water in Martin County are either industrial or mining-dewatering. The mining-dewatering uses are usually short-term uses which generally require on-site impoundment of withdrawn water. The only consumptive use in these operations is water lost to evaporation, which is insignificant for a regional model with a coarse grid. Therefore, mining-dewatering uses were not simulated in the model.

There are several industrial uses of ground water in Martin County, including Florida Power and Light, Pratt and Whitney, and Loxahatchee River Environmental Control District. Permitted industrial ground water use in Martin County totals 136 million gallons per month, or four percent of all modeled ground water well withdrawals.

CALIBRATION

Calibration is accomplished by comparing the response of the actual physical system with mathematical models calculated response to the same conditions. If they agree, the model is assumed to be calibrated. If not, various parameters in the mathematical model are altered until the model is in reasonable agreement with the physical system.

The Martin County model was calibrated to both steady state and transient conditions. Initial steady state runs served to make the first adjustments to the aquifer parameters used in the model. Once the model was able to run without errors, the adjusted aquifer parameter data sets then were used in the transient calibration runs, where they were refined further. After some refinement, the data sets from the transient calibration were used in the steady state model, and sensitivity analysis runs were made. Information from these runs was input back into the transient model and further refinements were made. Finally, the steady state model was re-run using the data sets from the latest transient calibration to obtain a final steady state run.

The calibration period was January 1989 through December 1989. This period was chosen because it is the most recent period represented by ample water level observations. Locations of the monitor wells in each layer used in the calibration process are shown in Figures 22 through 25. The strongly implicit procedure (SIP) was the solution method used in the calibration process. Overall, it resulted in a stable solution in an average of 13 iterations. The number of iterations was near the initially set limit of 50 until the "prescribed head" cells, with their large conductance values, were applied to the Lake Okeechobee and Atlantic Ocean layer one boundaries.

TRANSIENT CALIBRATION

Method

Following the initial steady state calibration run, a series of transient runs were made to calibrate the model to observed water levels. The transient runs comprised 12 stress periods of one month each. Each stress period contained four time steps.

Starting heads in each layer were calculated from water level data obtained from USGS monitor

wells in January 1989, the first month water level data were collected from a new expanded Martin County network. These data, along with surface water stage data for the same time period, were regionalized using a kriging interpolation technique, which estimated a head value for every cell based on the available data. Further refinements to these arrays were made during calibration runs. Figures 26 and 27 are contour plots of the starting head arrays.

The intent was to calibrate so that agreement between observed water levels in monitor wells and simulated water levels in the cells which represent the location of those wells were within one foot of each other and that the seasonal water level fluctuation pattern would be imitated by the model.

Hydrographs comparing observed and simulated water levels in cells that correspond to the locations of water level monitor wells were generated. These were used to aid in interpretation of the numerous model runs, particularly how the simulated water levels changed over time in response to varying stresses. These hydrographs are presented in Appendix F.

Agreement of simulated water levels with observed water levels can be affected by the following conditions:

1. MODFLOW simulates well withdrawals from a cell as a single stress located at the node, or center of the cell. In reality, the area represented by a cell may contain many pumping wells. This situation is common throughout the Martin County model, due to the size of the cells. Combining all the well withdrawals located within a cell and locating the total withdrawal at the center of the cell is not a completely accurate simulation. In addition, the computed head in a cell represents the average water level over a model cell. If actual levels vary significantly across the cell, monitor well levels may not closely match the computed levels. In areas of higher ground water gradients, such as those caused by intensive well withdrawals or where wells are located near surface water bodies causing strong natural gradients, water levels throughout a cell can vary significantly from the average. Cell-wide averaging effects are

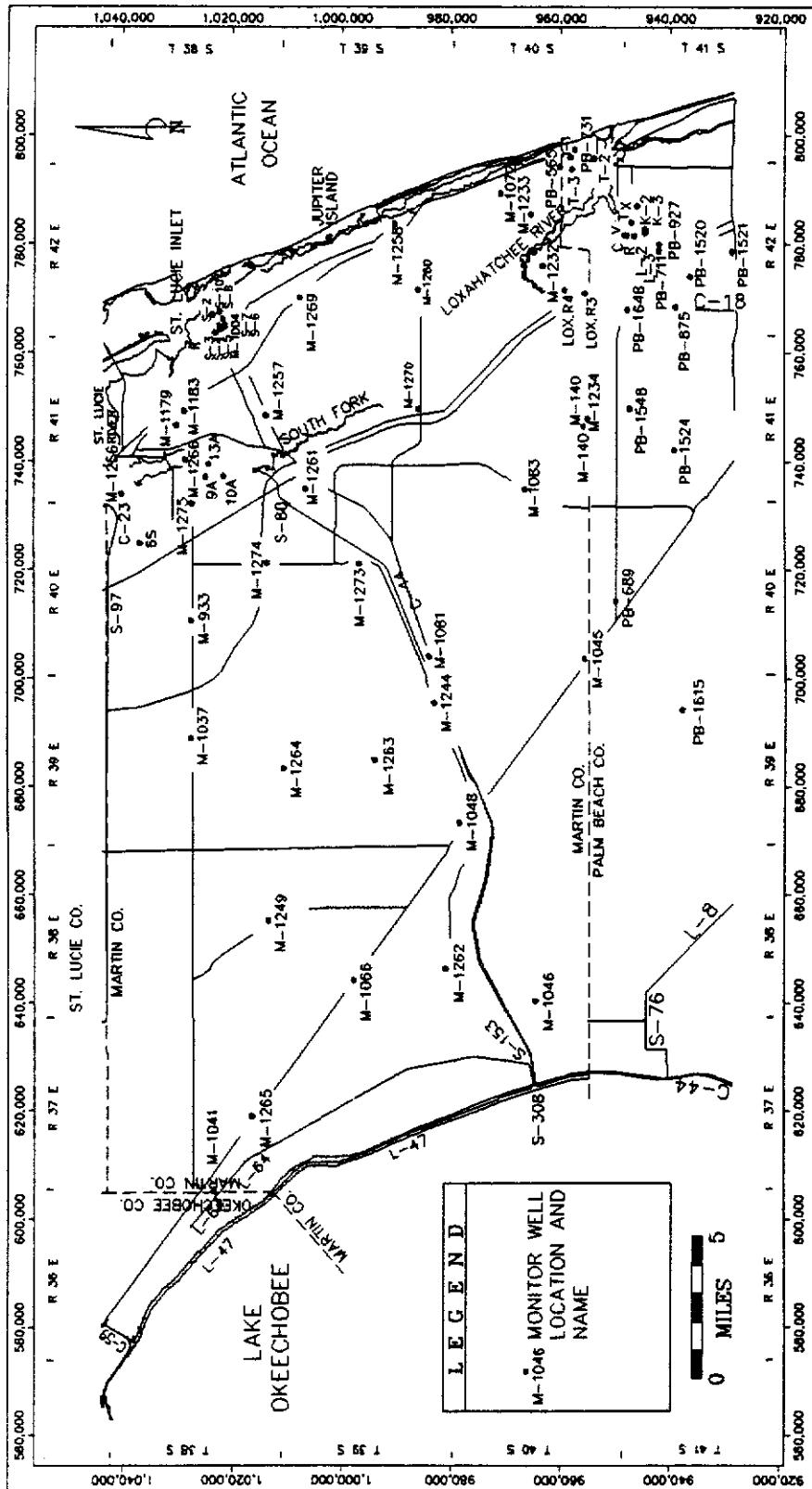


FIGURE 22. Observation Wells, Layer 1

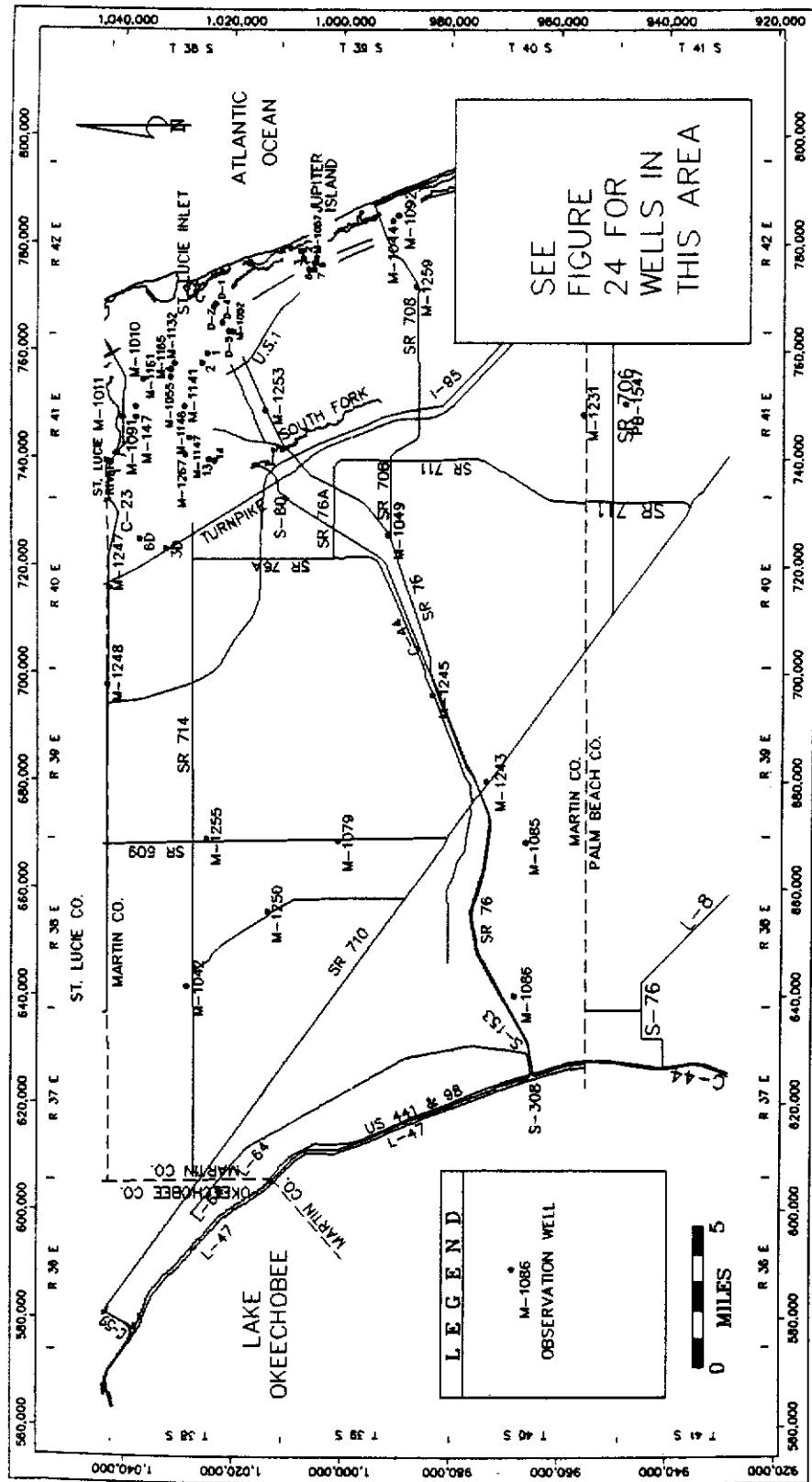


FIGURE 23. Observation Wells, Layer 2

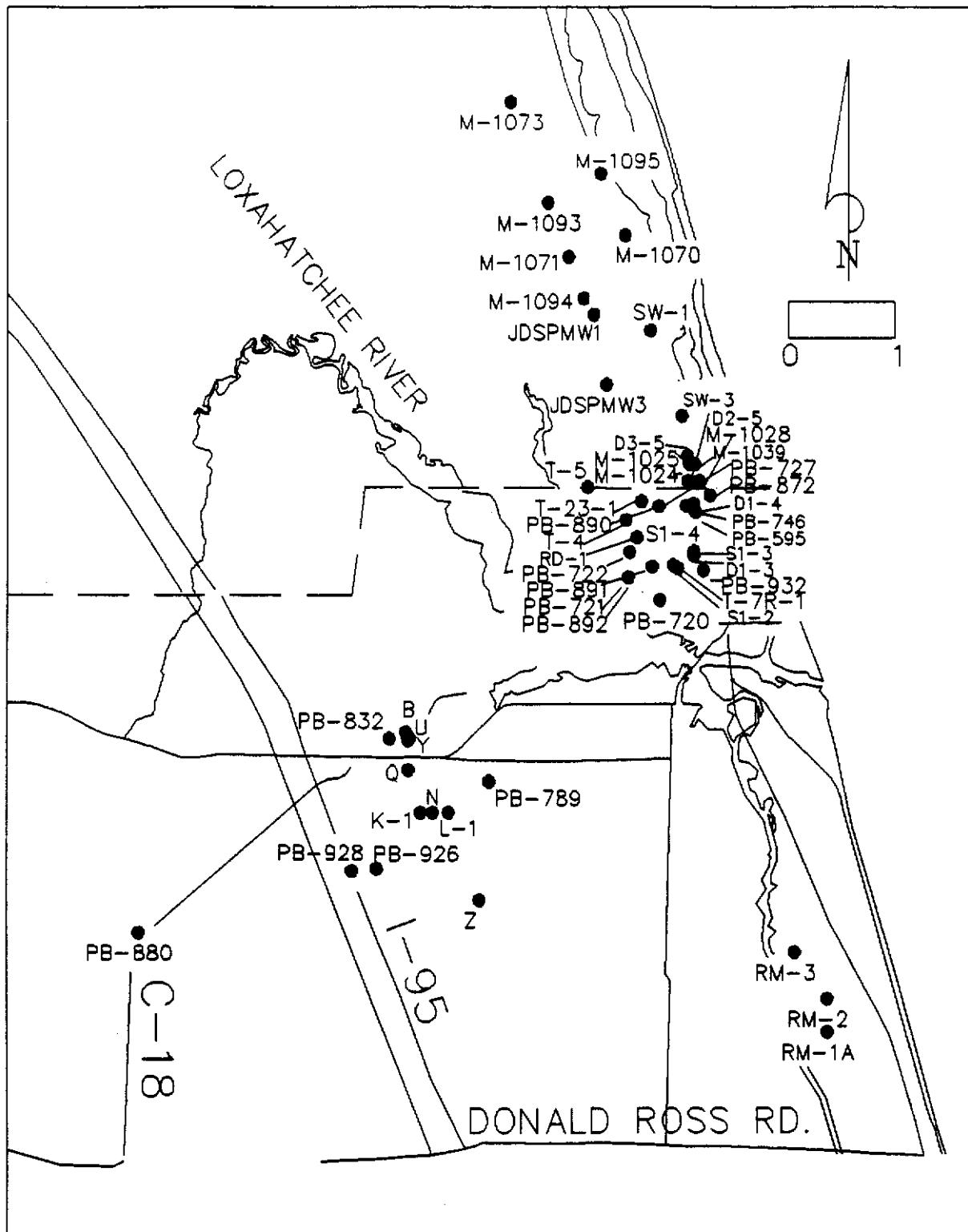
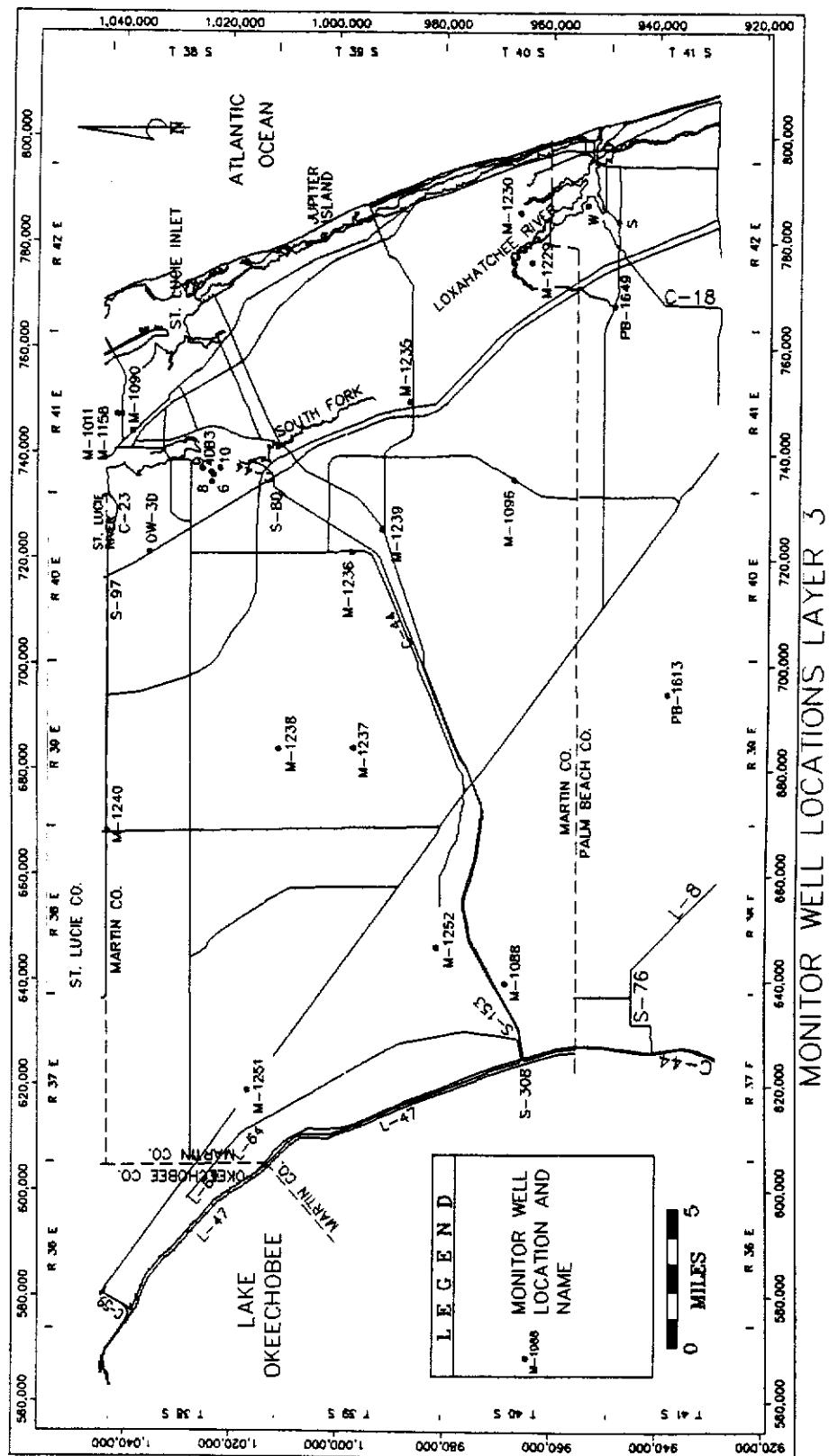


FIGURE 24. Observation Wells, Layer 2 (Tequesta/Jupiter Area)



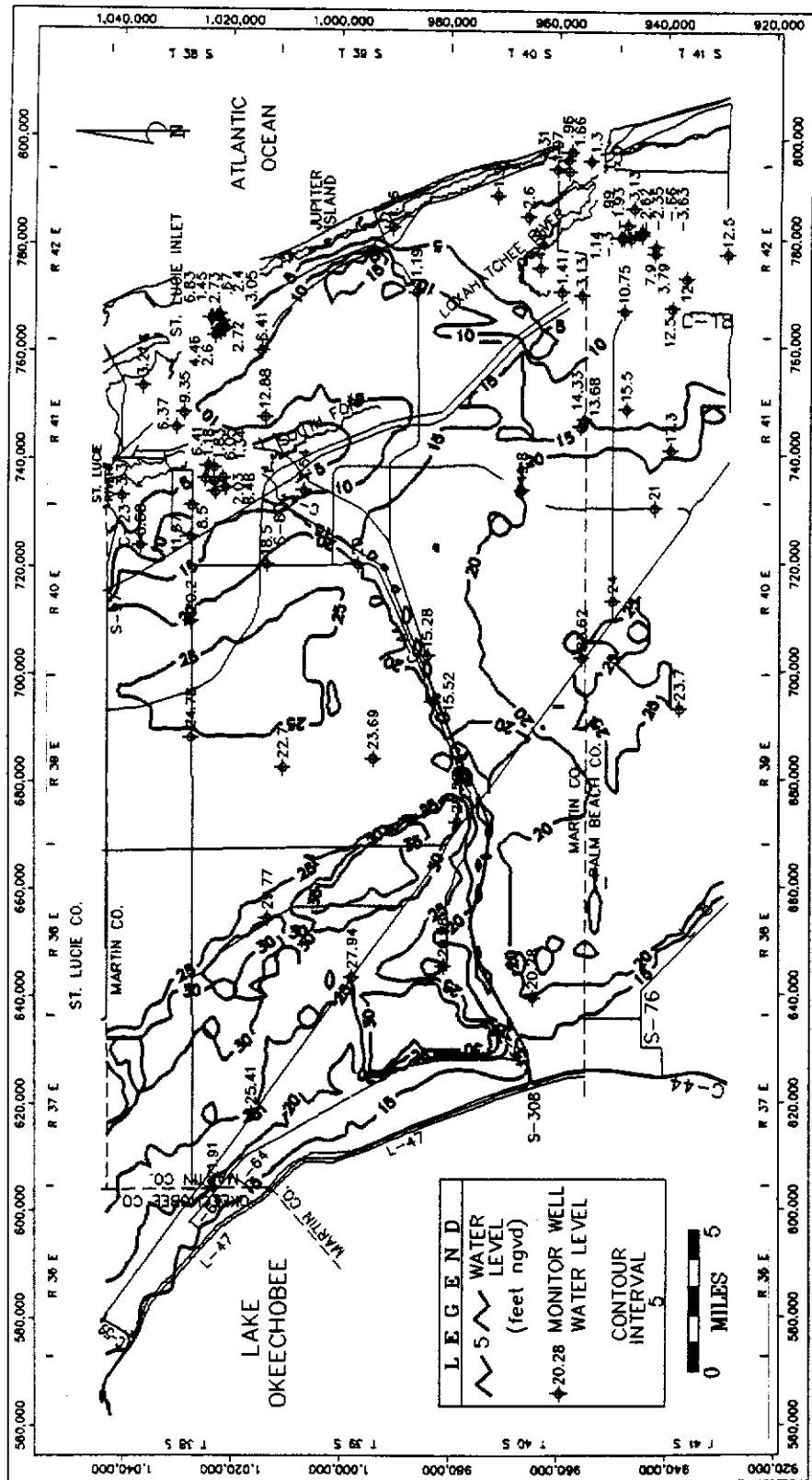


FIGURE 26. Starting Heads, Layer 1

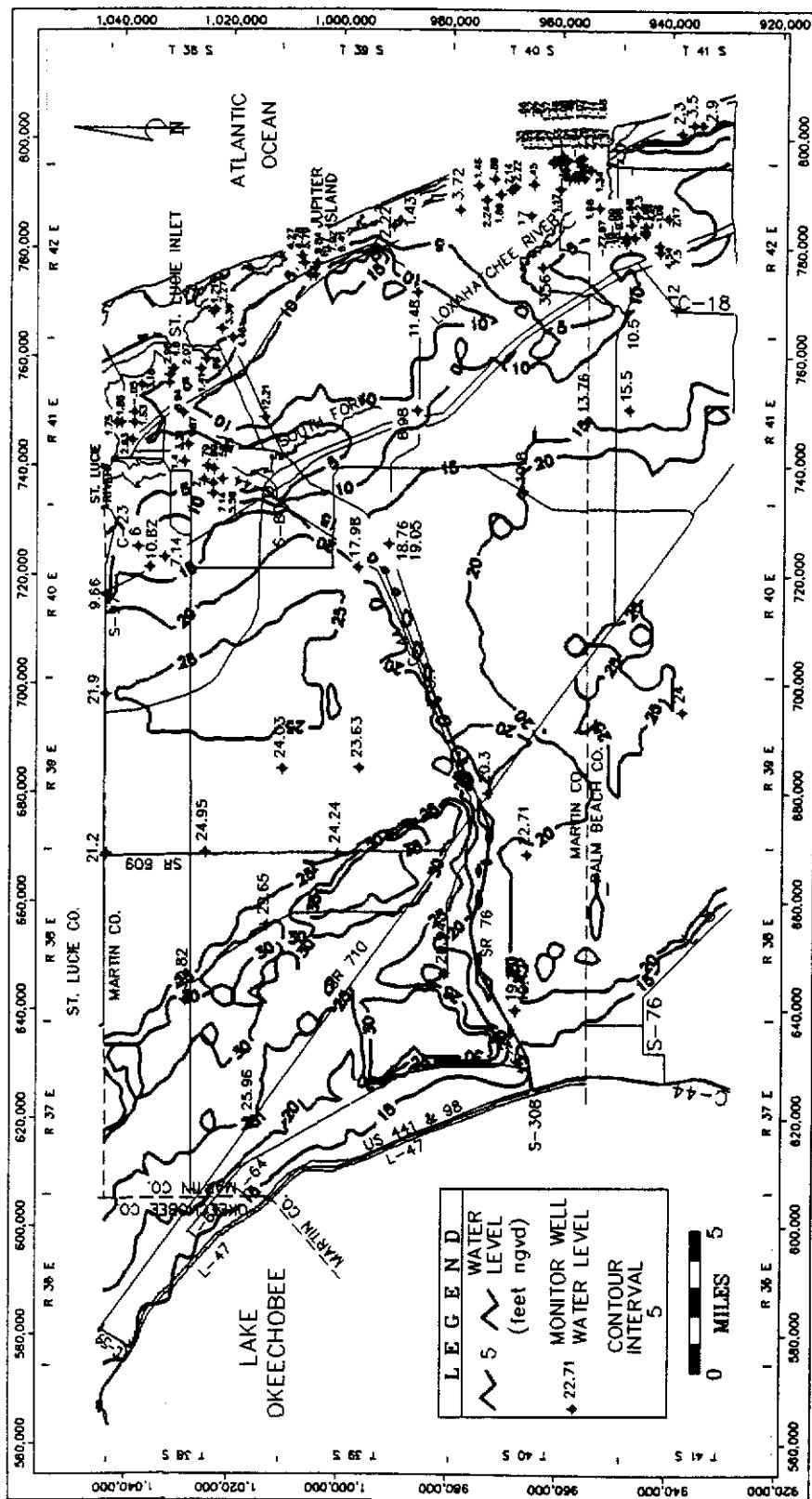


FIGURE 27. Starting Heads, Layers 2 and 3

- evident in comparing observed and computed levels in the cells containing monitor wells in all the major wellfields.
2. The model was run using one month stress periods, consequently the model water levels reflect the average effect of stresses that occurred throughout the month. However, a monitor well will reflect the most recent events affecting water levels around the well (canal stage changes, well withdrawals, rainfall events) just before the water level reading was taken. Also, monitor well readings were usually collected near the end of the month but could have been taken anytime in the latter half of the month. These situations can cause some discrepancy between the model and observation well levels used to check calibration.
 3. Most of the rainfall in the study area occurs as intense short term events over relatively small areas. In many cases, ground water levels respond almost immediately to these events. A local rainstorm during any of the measuring periods could result in water level increases in selected wells reflecting a local phenomena rather than a regional trend. Also, some of the observation wells are located a significant distance from a rainfall station, so an intense rainfall event causing water level fluctuations at a given well may not be represented in the rainfall data.
 4. Inspection of aerial photography reveals that Martin County has a large network of canals, ranging in width from several feet to hundreds of feet. Only canals with some data on depths, configurations and control elevations were included in the model. In general, these were grove canals, some pasture canals and the SFWMD canals. This omits many smaller roadside drainage systems. An observation well near a canal not included in the model could then indicate the model is not accurate in that area. And, as mentioned before, if the monitor well is in the same cell as the canal reach, cell-wide averaging effects can sometimes make it impossible to calibrate the model to the observation well water level.

Because all the layers of the model are basically under atmospheric conditions and there are no significant confining units between layers, modeled water levels in the three layers were generally the same by the end of each one month stress period. Any changes in the evapotranspiration, recharge or river/drain packages affected all three layers

similarly. Therefore, calibration discussions will not address individual layers, but the model as a whole.

Most of the calibration changes were made in one of three areas: 1) river/drain conductance, 2) starting head levels, and/or 3) evapotranspiration surface. After the initial runs, two observed versus modeled hydrograph patterns became apparent. Either the model initial value was much higher or lower than the observation well and the well was never able to recover from that poor starting point, or the initial level was accurate but as the model progressed the modeled water level became too high, starting to come down by the end of the calibration period. In the former situation, adjustments to the starting head file usually corrected the problem which was probably caused by the statistical interpolation program used to create the file.

In the latter situation, water seemed to "mound" during the summer rainy months. Adjustments to rainfall were attempted but were not particularly successful. Eventually it was discovered that adjustments in the evapotranspiration (ET) surface would correct the problem. If the ET surface is lowered, the ET extinction point is then deeper and the ET rate becomes larger at the same depth which results in more ET which removes the water that was "mounding". The opposite situation can be affected by raising the ET surface to correct situations where the modeled level is too low. Changes of one or two feet were usually sufficient to cause the model to calibrate. This method, while effective, is tedious and can only be changed and verified on a local level. In cells without a monitor well, which is the majority of cells, this fine tuning is not possible.

The ET surface was based on land surface elevations which were determined from USGS topographic quadrangles which were overlain with the model grid. Although some grid cells had elevation changes of 20 feet or more, it was necessary to average the elevation for model input. The elevation contour lines are at five foot intervals, generally leaving a ± 2.5 feet range for adjustment when calibrating the ET surface of the model. In the areas where elevations change rapidly, the model would be more accurate with a smaller cell size. In wetlands areas, modeled water levels were too low and using the above method would have resulted in an evapotranspiration surface well above land surface. Therefore, coefficients used in creating the maximum evapotranspiration rate array were altered until the resulting array, when used in the model, led to calibration with observed water levels.

The other parameter which measurably affected water levels was river and drain conductances. There are many wells, in the modeled area, near large surface water sources. The model was run several times using different river and drain conductance multipliers and checking calibration of nearby wells. Reaches which calibrated well at certain multipliers were noted and finally the river and drain files were modified to reflect the best multiplier for each reach. The Loxahatchee River changes from drain reaches upstream to river reaches in the brackish/tidal areas. The conductances are significantly different between the river and drain sections. The model documentation (McDonald & Harbaugh, 1988) states that the conductance term is best used as a calibration parameter and does not necessarily reflect a natural condition. Apparently, because of the way the model handles flow in and/or out of river versus drain reaches, the conductance values that resulted in a good calibration are different for the two types.

Results

Agreement of one foot or less between observed water levels and simulated water levels in cells which represent the location of those wells, for at least 75 percent of the stress periods was the calibration criteria. For this model that means that for nine out of the twelve months, modeled water levels had to be within a foot of the observed level.

The wells were broken into three calibration categories: 1) wells that met the calibration criteria, 2) wells that did not meet the criteria but the reason for being outside the range is explainable, and 3) wells that did not meet criteria, indicating an area of

the model that needs further refinement. Table 6 presents the current status of observation wells used in the transient model calibration.

Wells categorized as "explainable" did not meet calibration criteria but other influences, such as those previously discussed, prevented a better apparent calibration. In layer one, wells M-1046, M-1083, and M-1265 may be affected by ET parameters; wells M-1262, M-1263, and M-1270 may be affected by drain cells; and wells M-1048, M-1081, M-1232, M-1256, M-1269, M-1274, PB-1520, Pipers Landing well 9A, and PB-927 have no obvious starting point from which to seek a better calibration. In layer two, wells M-1086 (ET problems), M-1085 (grove drain), M-1010, M-1049, M-1161, M-1253, PB-720, T-4 (Tequesta) and U (Jupiter) did not meet the calibration criteria and probably indicate areas where more work is needed on the model. Non-calibrated wells in layer three are M-1088, M-1096, M-1236, M-1238, M-1230, M-1235, and Pipers Landing wells 6, 8, 9, 10 and 40B3.

Figures 28 through 30 depict the average difference between observed and modeled water levels over the entire transient calibration period for each monitor well. This map gives a general indication of model calibration; however, if the model water level is much higher than observed during one stress period and then equally too low at another time, they would, of course, cancel themselves out, resulting in a small average difference. But if a well or group of wells is consistently high or low, this would show up and give guidance on which areas need work.

Table 6: Transient Calibration Results

	Layer one		Layer two		Layer three		Total	
	#	%	#	%	#	%	#	%
Calibrated	42	58	49	51	11	44	102	53
Explainable	15	21	38	40	3	12	56	29
Not Calibrated	15	21	9	8	11	44	35	18

= number of observation wells

% = percentage of observation wells in the respective layer

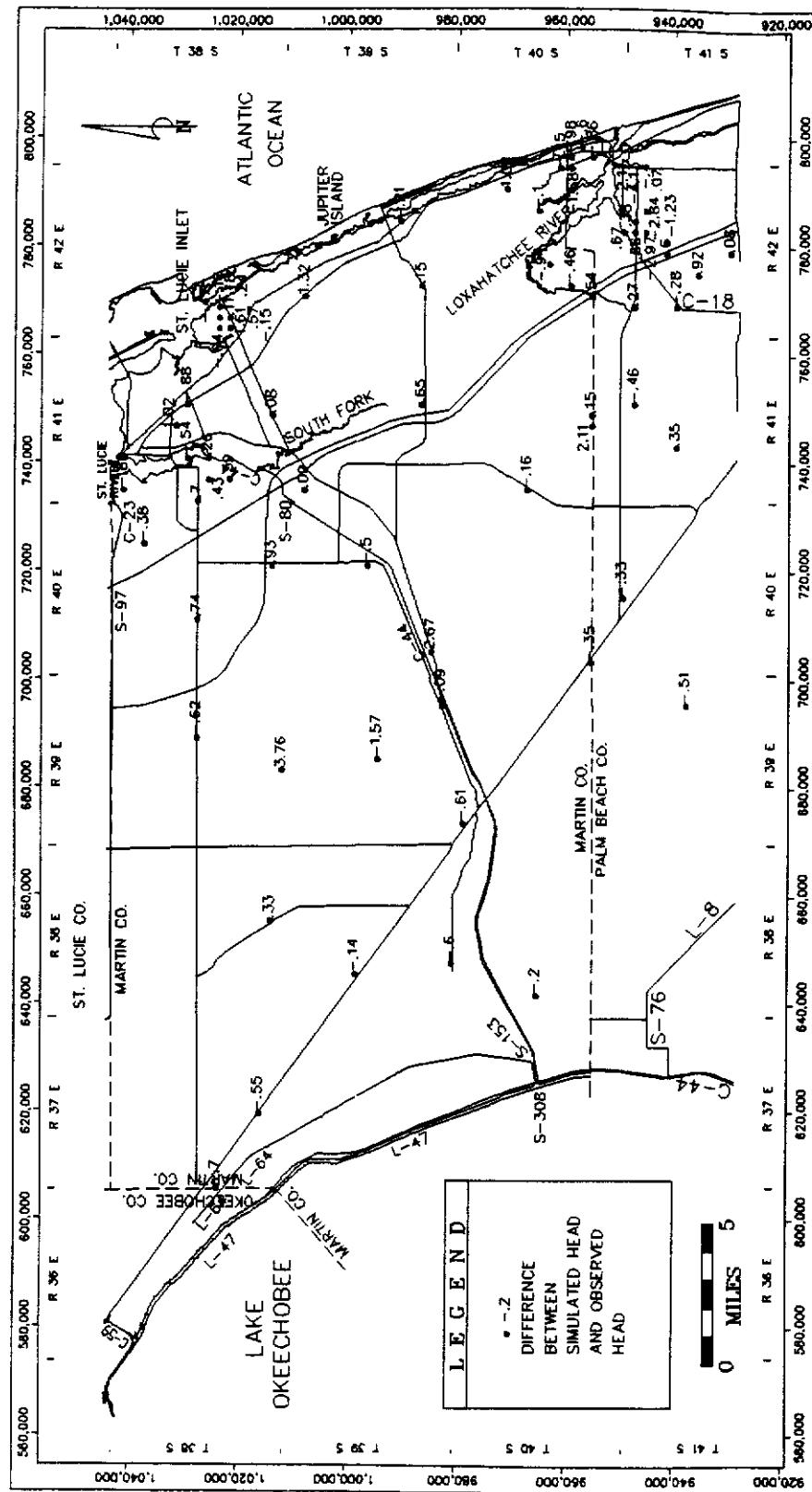
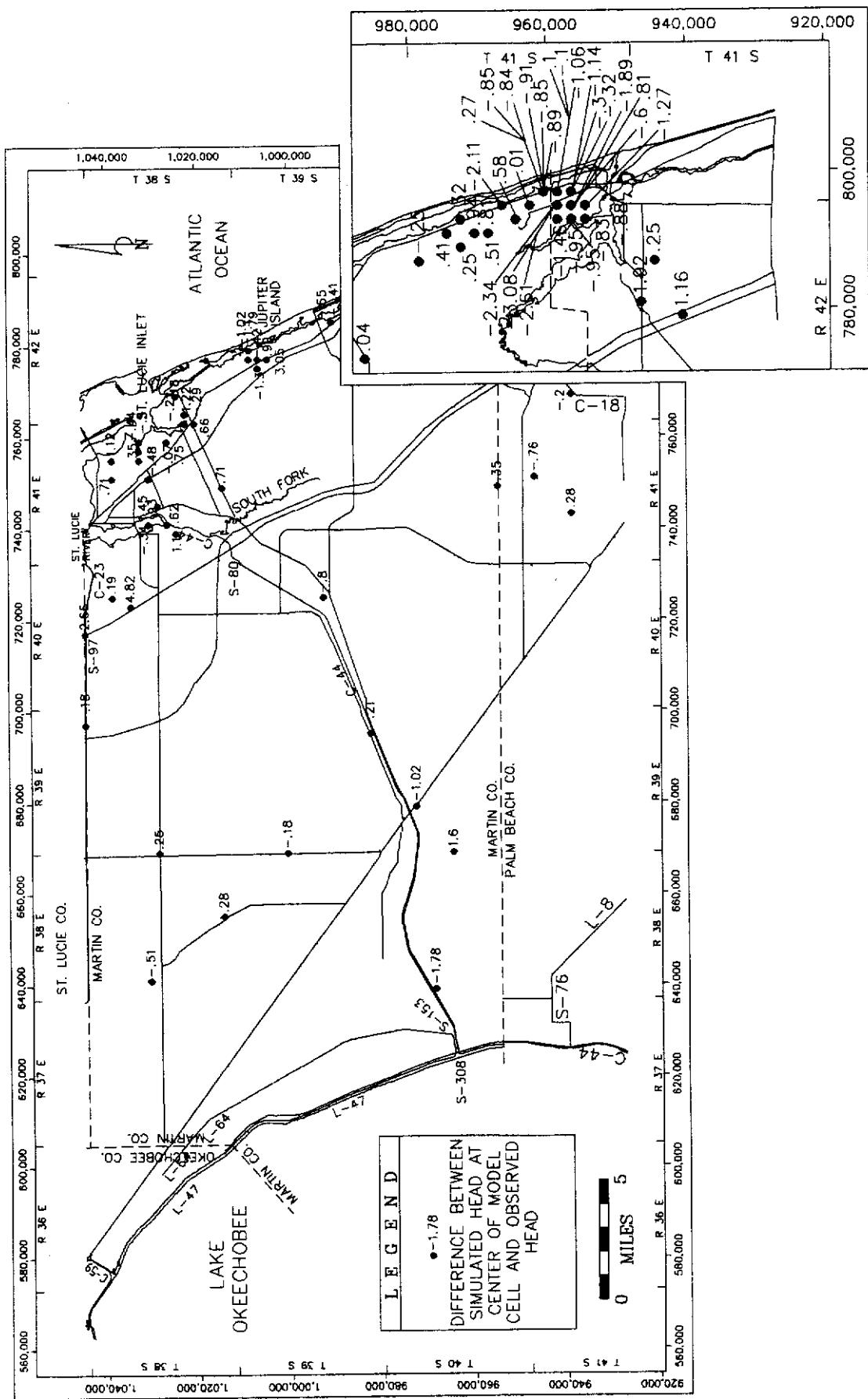
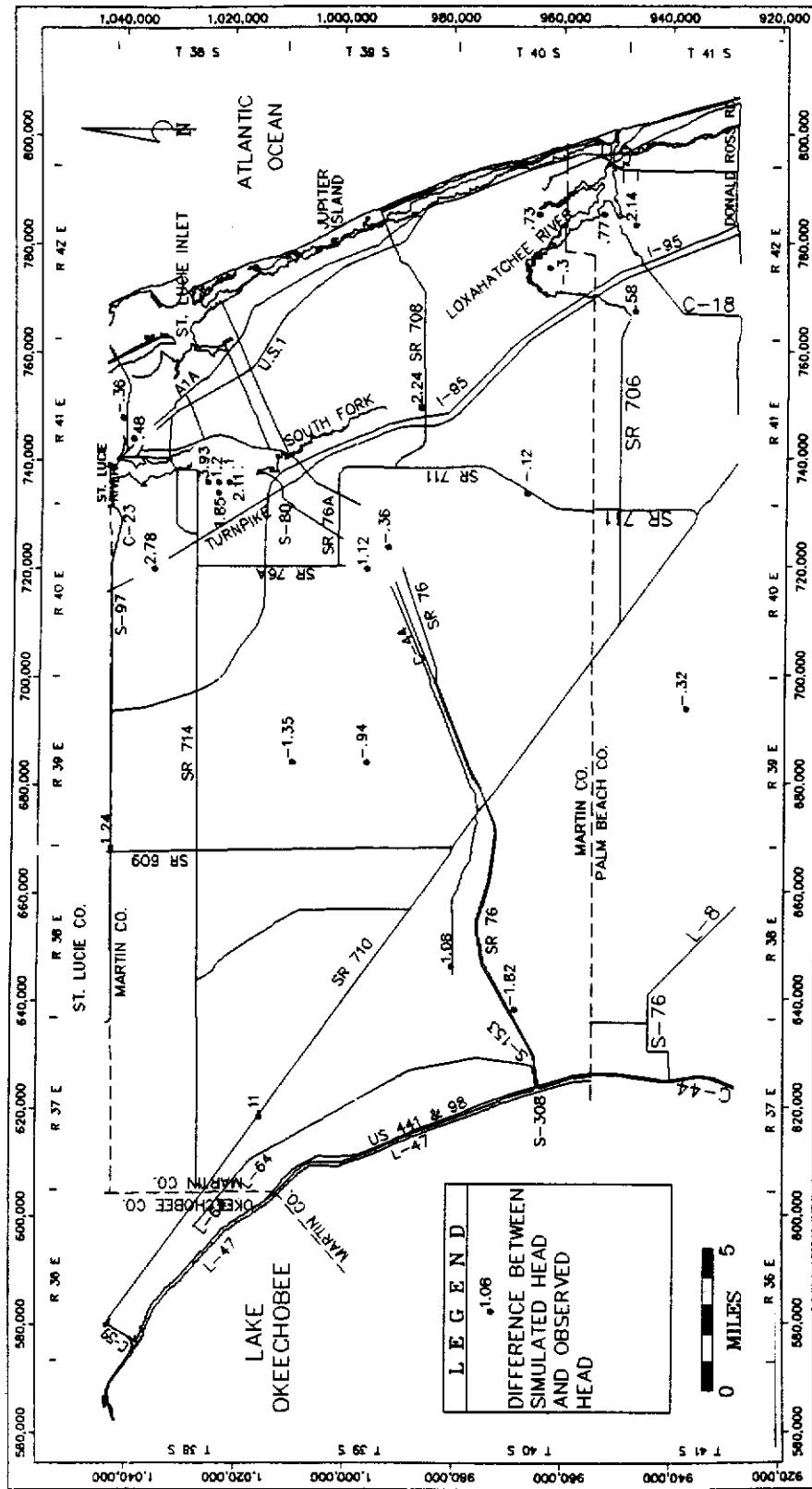


FIGURE 28. Average Difference Between Observed and Computed Water Levels, Layer 1

FIGURE 29. Average Difference Between Observed and Computed Water Levels, Layer 2





STEADY STATE CALIBRATION

Method

"Steady state" can be viewed as an average condition achieved over a long period of time, and assumes that no major changes in stress rates occur during that time. When the stresses that drive ground water flow change very slowly in time relative to the rate of change within the aquifer system, steady state assumptions are justified. In many cases, however, the steady state condition is hypothetical due to the artificially rapid changes applied to the aquifer system. A pre-development condition for Martin County was present earlier in this century, but little or no data exists that could be used to reproduce it. At the present time, the aquifer system is in a dynamic transient process, but on a monthly basis behaves in a "quasi-steady-state" manner.

Ideally, the steady state runs would have been calibrated using predevelopment data whereby disturbances to the steady state condition would not exist. Average values of recharge, evapotranspiration, pumpage, and surface water stage elevations were used, calculated from the monthly values for 1989. January 1989 water levels were used for the starting head array. The model was run for one stress period broken into twelve 30-day time steps. The resulting modeled water levels (Figures 31, 32 and 33) represent an average 1989 condition and are best used for sensitivity analysis and differences between predictive scenarios rather than to determine specific water level information for a given time period.

Results

The steady state calibrations were based on the assumption that the ground water levels during the

calibration period were fluctuating around a steady state condition as a result of seasonal variations in rainfall, pumpage, evapotranspiration and canal levels. Further, the average measured ground water levels during the period were assumed to approximate steady state levels under average 1989 conditions. Thus, the steady state calibrations were made based on comparison of simulated water levels under 1989 recharge/discharge conditions versus the measured water levels in surveyed wells during the calibration period. A well was considered calibrated if the modeled water level fell within the minimum to maximum water level range for that well or no more than 0.1 feet outside the range for the calibration period. Figures 34a-d illustrate the differences between the simulated steady state water levels and the average measured water levels in these wells during the calibration period. Differences between the average measured levels and the minimum and maximum measured levels are shown in the same figures.

The wells were broken into three calibration categories: 1) wells that met the calibration criteria, 2) wells that did not meet the criteria but the reason for being outside the range is explainable, and 3) wells that did not meet criteria indicating an area of the model that needs further refinement. There is a discussion in the transient calibration section on the different situations that can influence model results and make an observation well appear uncalibrated. Table 7 gives the breakdown of the calibration results for the steady state model.

Most of the uncalibrated wells which indicate areas needing work, also fell into the same category in the transient calibration results. The following wells in layer one did not meet calibration criteria, indicating areas needing further model refinement: M-1081,

Table 7: Steady State Calibration Results

	Layer one		Layer two		Layer three		Total	
	#	%	#	%	#	%	#	%
Calibrated	48	67	51	53	17	68	116	60
Explainable	19	26	39	41	5	20	63	33
Not Calibrated	5	7	6	6	3	12	14	7

= number of observation wells
% = percentage of observation wells in the respective layer

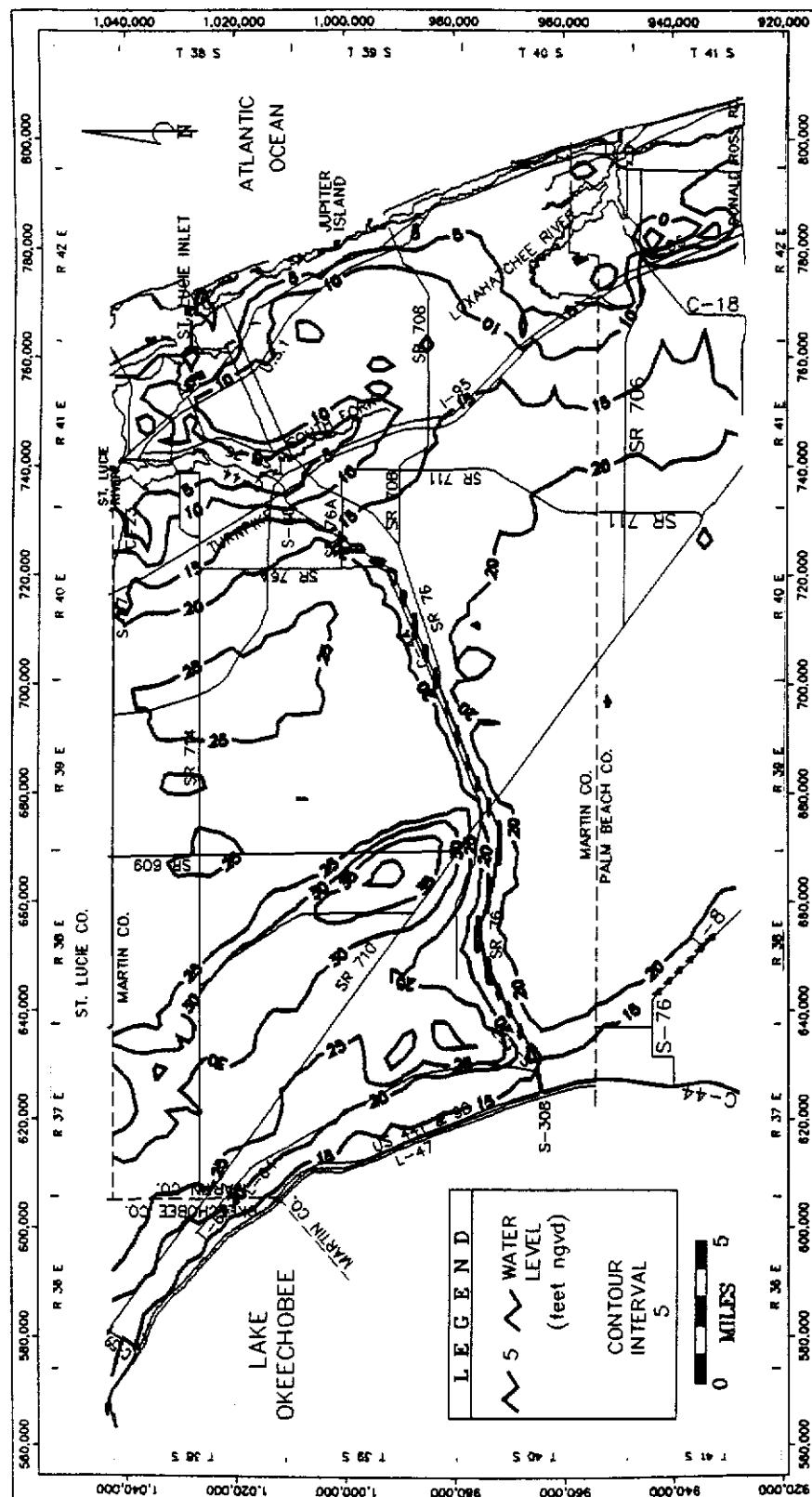


FIGURE 31. Computed Water Levels in Layer 1, Steady State

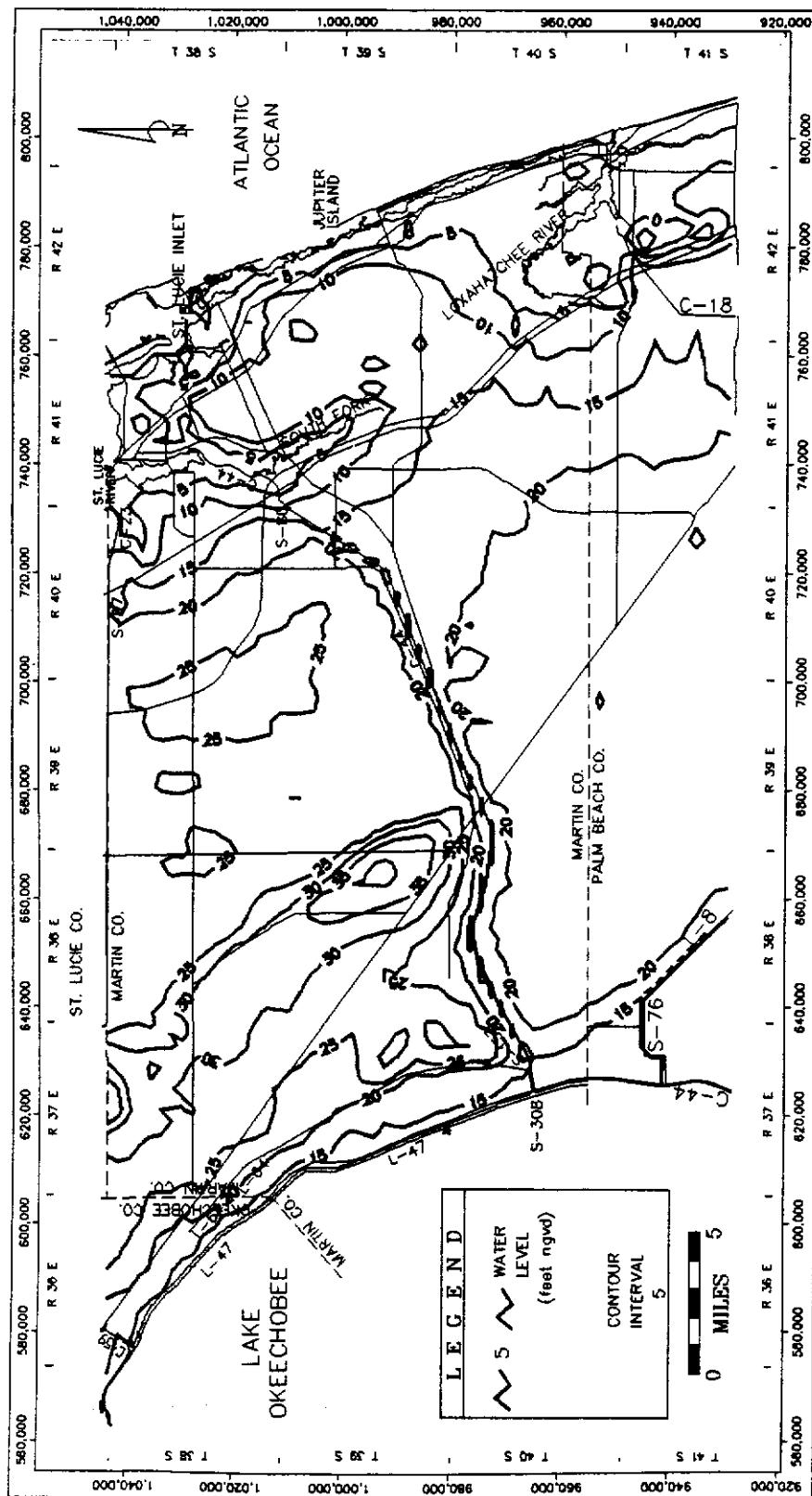


FIGURE 32. Computer Water Levels in Layer 2, Steady State

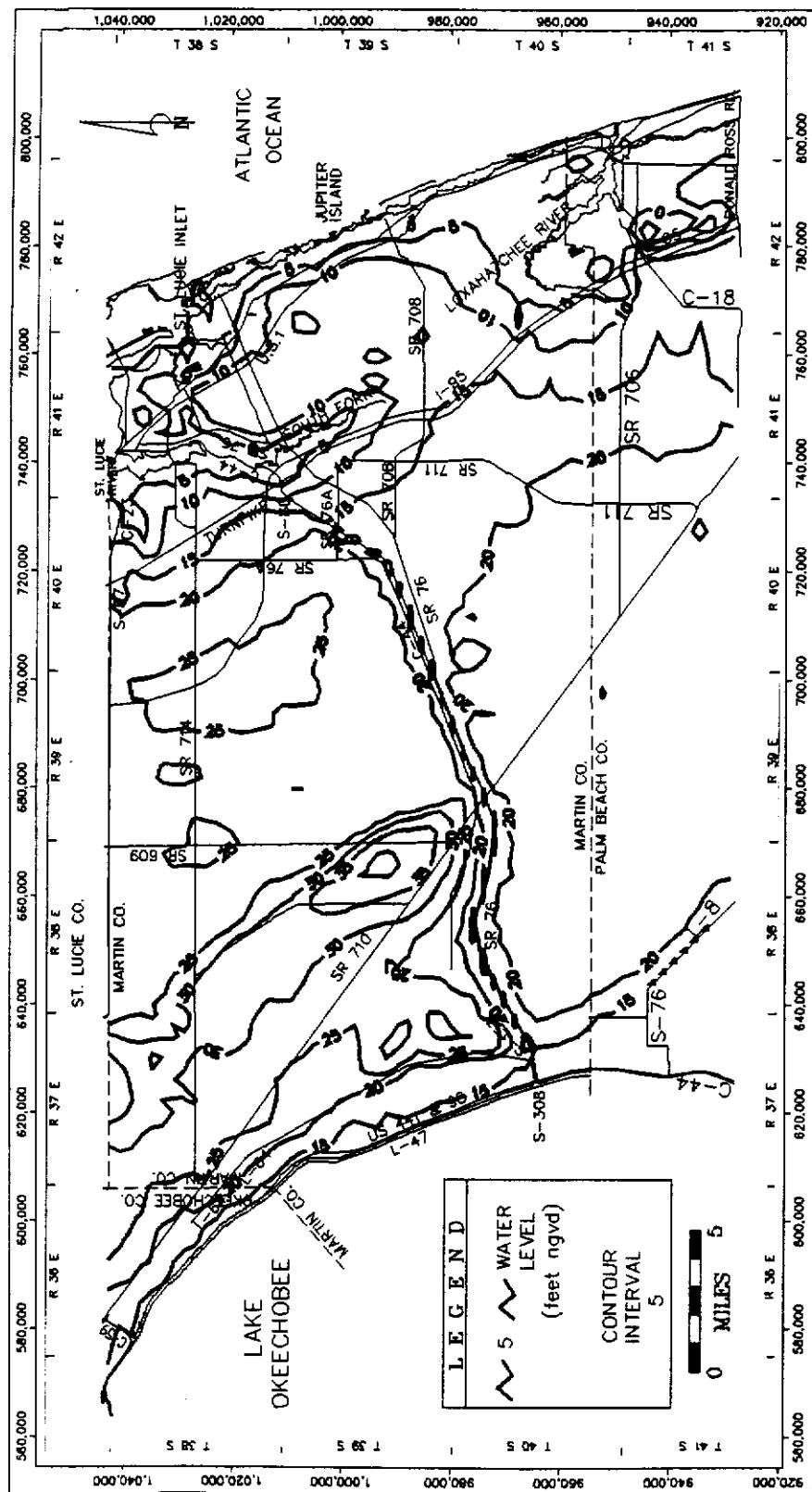


FIGURE 33. Computed Water Levels in Layer 3, Steady State

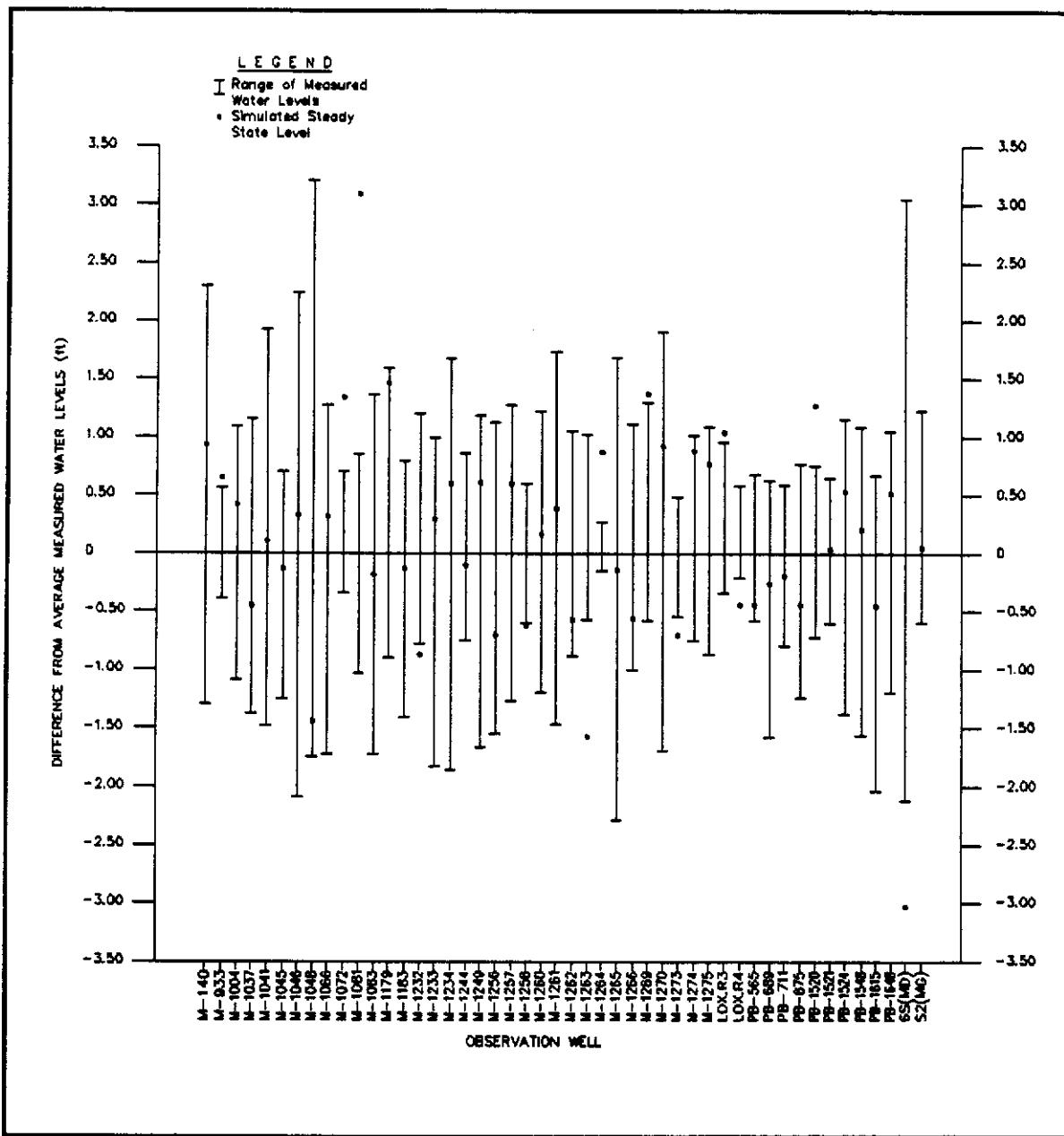


FIGURE 34a. Steady-State Calibration Residuals from Average Measured Water Levels

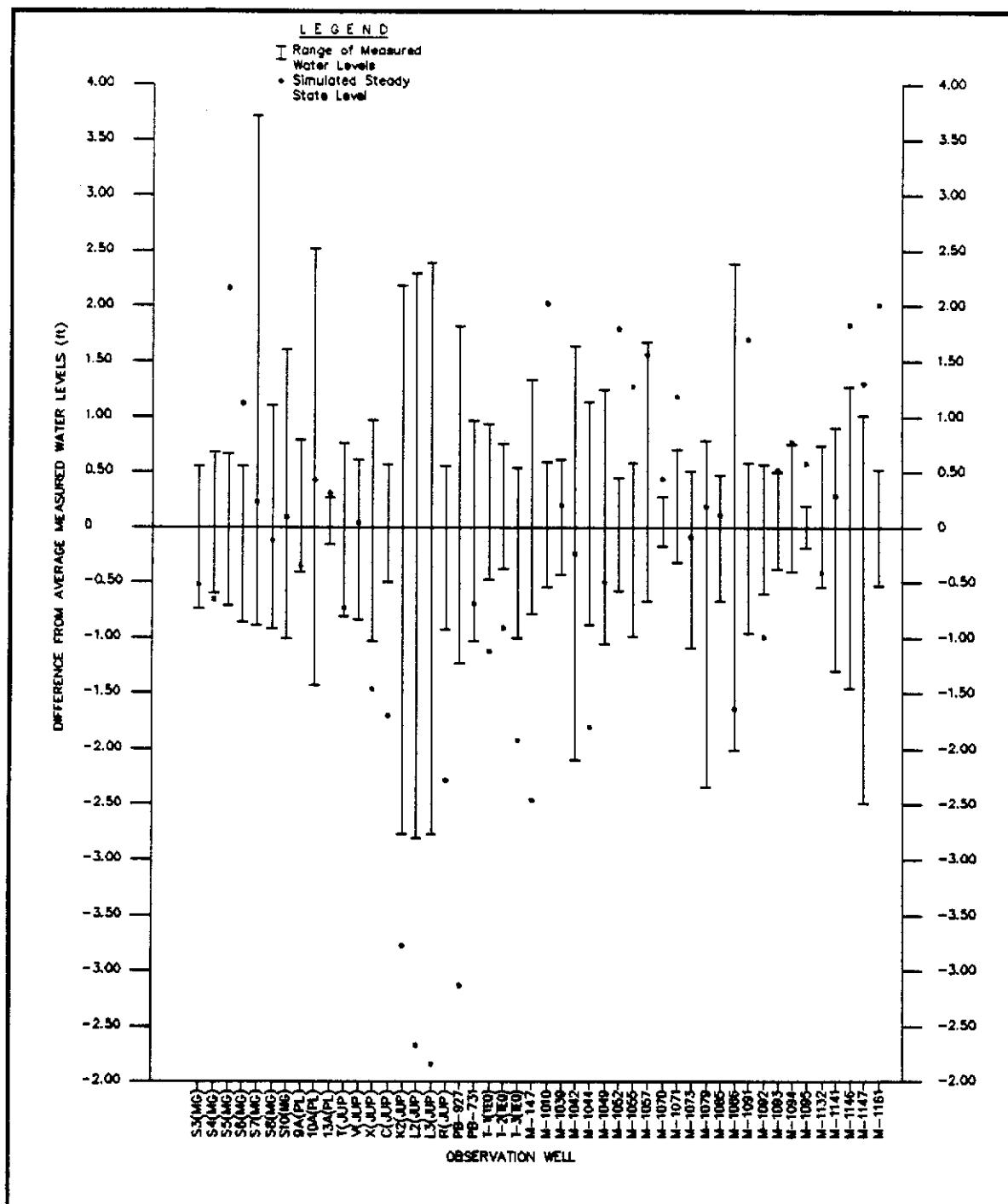


FIGURE 34b. Steady-State Calibration Residuals from Average Measured Water Levels

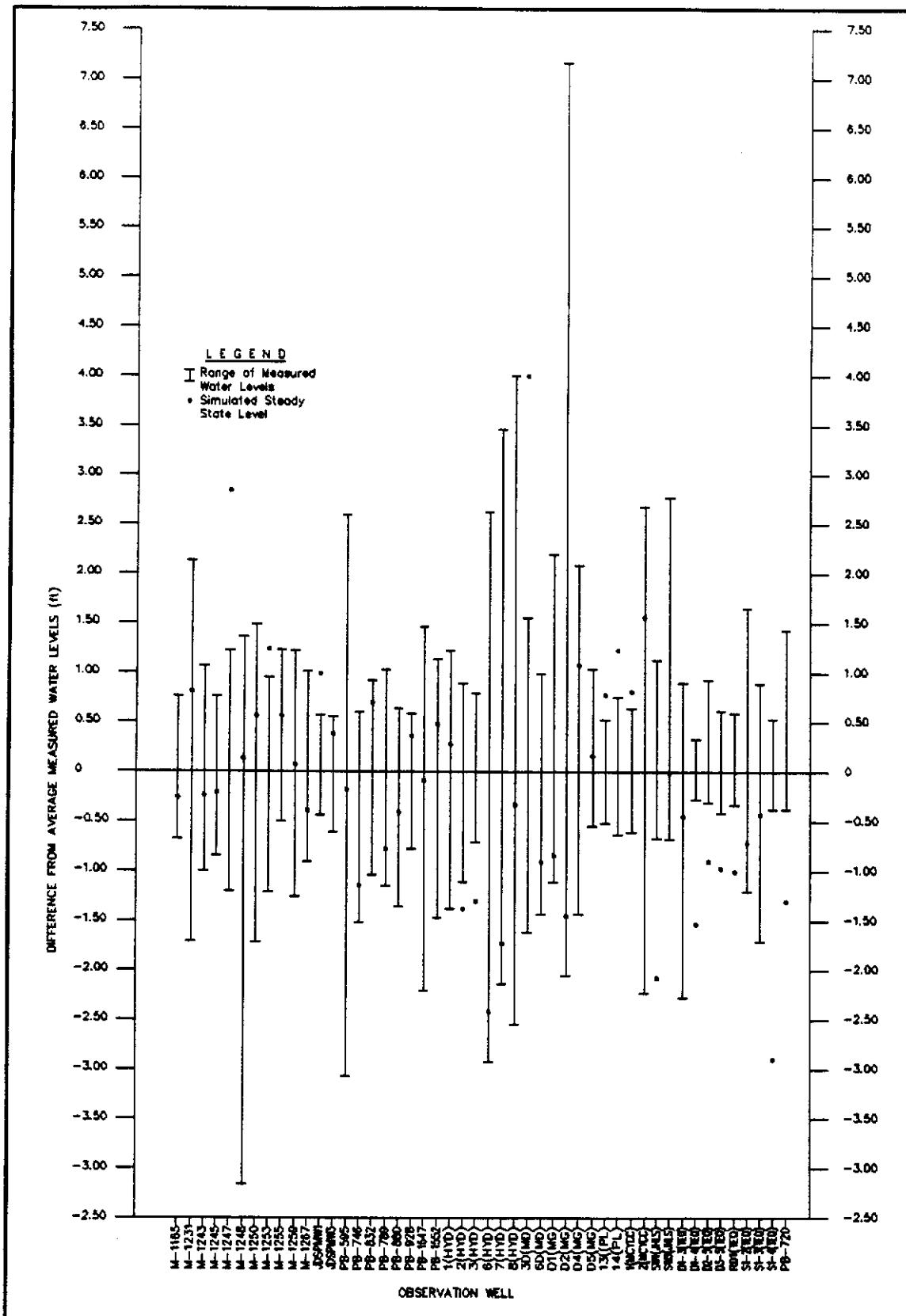


FIGURE 34c. Steady-State Calibration Residuals from Average Measured Water Levels

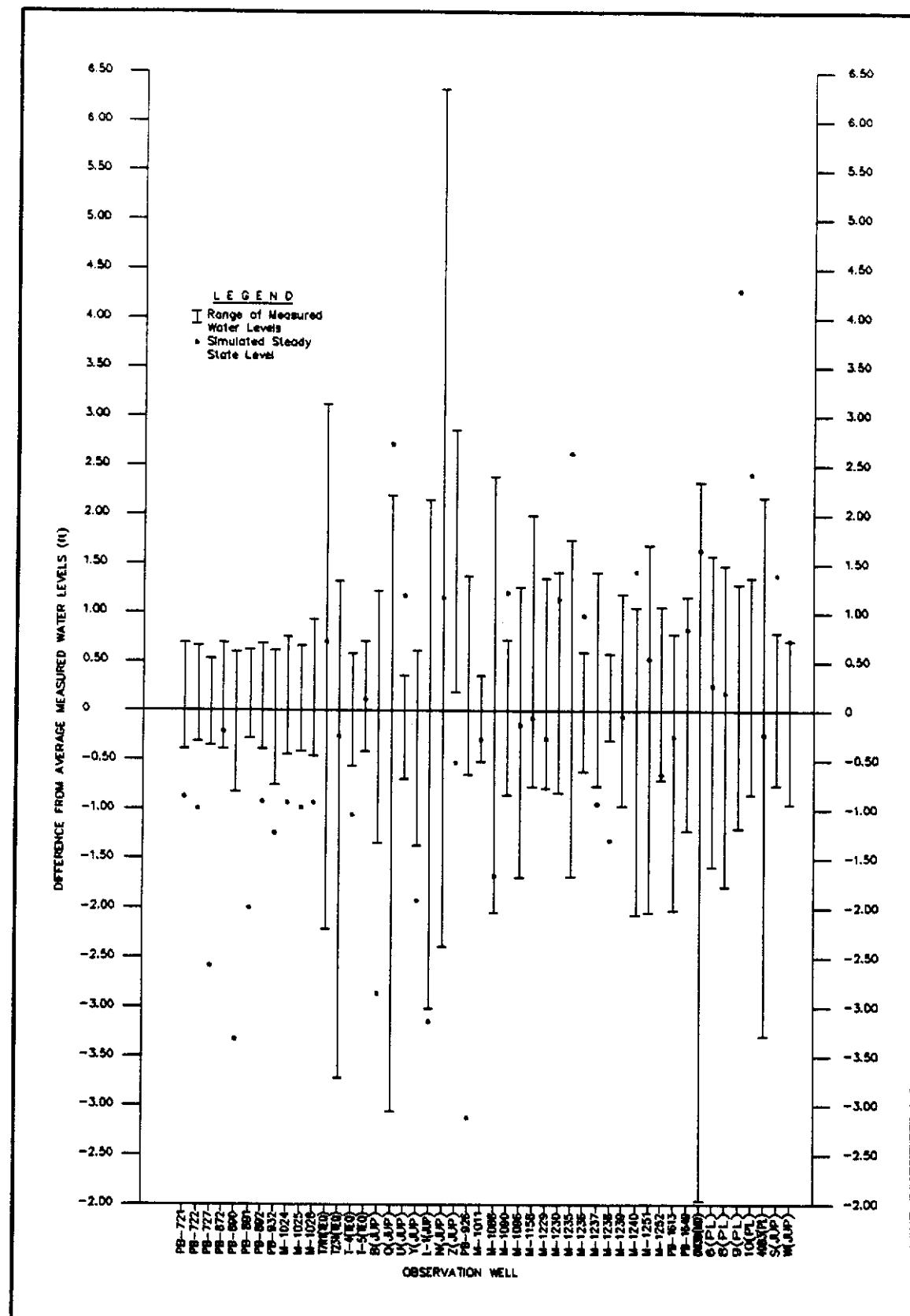


FIGURE 34d. Steady-State Calibration Residuals from Average Measured Water Levels

M-1232, LOX-R4, PB-1520 and PB-927. In layer two, the uncalibrated wells are M-1010, M-1055, M-1161, M-1253, PB-720 and T-4 (Tequesta). For layer three, they are wells M-1235 and Pipers Landing wells 9 and 10.

Budget and Flows

Layer One Figure 35 shows the direction and magnitude of simulated horizontal flow in layer one. Each arrow represents the flow from an individual cell. The majority of the larger flow vectors are associated with intensive ground water use or interactions with surface water bodies. The flow vectors north of Indiantown represent flow from a topographic high (the Osceola Plain), steeply declining and then intercepting grove canals which maintain water levels lower than land surface. Flow vectors are not shown in the Okeechobee portion of the model due to graphic problems associated with expanded grid cells.

An analysis of the volumetric budget for layer one is shown in Figure 36. The majority of flow into this layer (86 percent) is derived from recharge (rainfall), 10 percent is upward leakage from layer two, one percent is river leakage, and three percent is from the general and "prescribed" head cells, representing flow from outside the model, mainly from St. Lucie and Okeechobee counties and Lake Okeechobee. Of the total flow out of layer one, 63 percent is to evapotranspiration, 19 percent is leakage to layer two, less than one percent is agricultural well pumpage, six percent is river leakage, 11 percent is into drains and the remaining one percent is flow to the general and "prescribed" head cells, representing flow out of the modeled area, mainly to the Atlantic Ocean and Palm Beach County.

Layer Two Figure 37 shows the magnitude and direction of simulated horizontal flow in layer two. Most of the larger flow vectors are associated with intensive ground water use, for example the Jupiter and Hobe Sound wellfields. Figure 38 is a representation of the simulated vertical flow between layer two and the overlying layer. Upward flow into layer one is generally to river or drain cells.

The largest downward flow from layer one is associated with well withdrawals in layer two.

Figure 39 illustrates the volumetric budget for layer two. Approximately 82 percent of the total inflow to this layer is recharge from layer one, 16 percent is inflow from layer three, two percent is from the general head cells, and one percent is recharge (rainfall) in cells where the model determined that the vertically adjacent cell in layer one was inactive. The flow from the general head cells represents flow into the modeled area from all boundaries. Of the total outflows, 45 percent is upward leakage to the water table aquifer, 37 percent is to wells, 16 percent is downward leakage to layer three, and two percent is to the general head cells.

Layer Three Figure 40 shows the magnitude and direction of simulated horizontal flow in layer three. The larger flow vectors are associated with intensive ground water withdrawals associated with the Jupiter and Hobe Sound wellfields. Figure 41 illustrates the simulated leakage between layers two and three. Most of the flow is upward to recharge layer two and large upward flow vectors indicated intensive withdrawals from layer two, for example in Jupiter.

The volumetric budget for layer three is illustrated in Figure 42. Almost all of the inflow to layer three (97 percent) is recharge from above. The remaining three percent comes from the general head cells. Of the total outflow, 95 percent is upward leakage to layer two and five percent is to general head cells.

A combined steady state volumetric budget for all of the modeled area is presented in Figure 43 and Table 8. Total inflow consists of 95 percent recharge (rainfall), four percent flow from general head boundaries (flow from outside the modeled area), and one percent from river leakage. Total outflow consists of 70 percent evapotranspiration, nine percent to wells, one percent to general head boundaries (flow out of the modeled area), and 19 percent discharge to surface water bodies (12 percent to drains and seven percent to rivers).

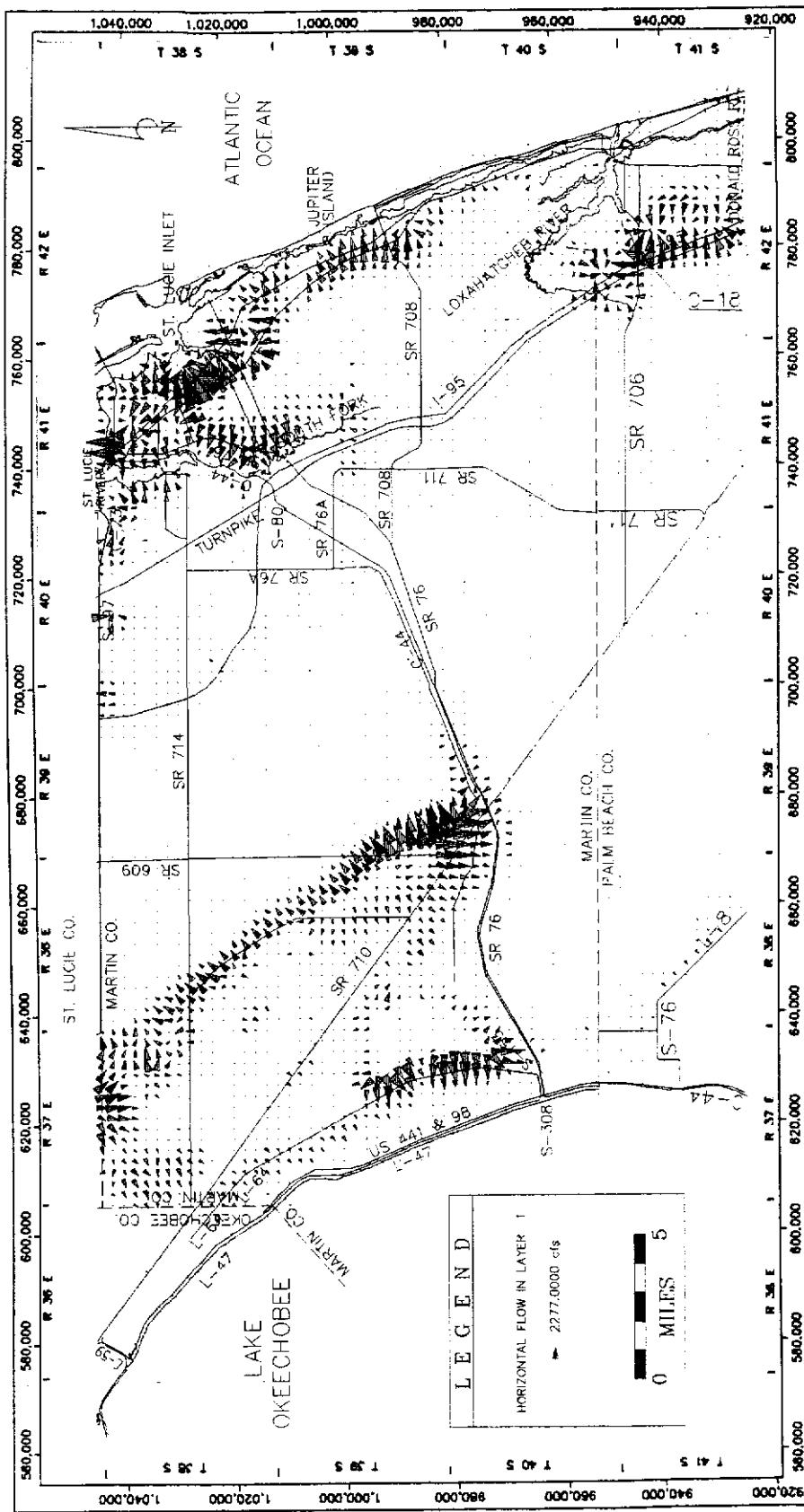


FIGURE 35. Magnitude and Direction of Horizontal Flow in Layer 1, Steady State

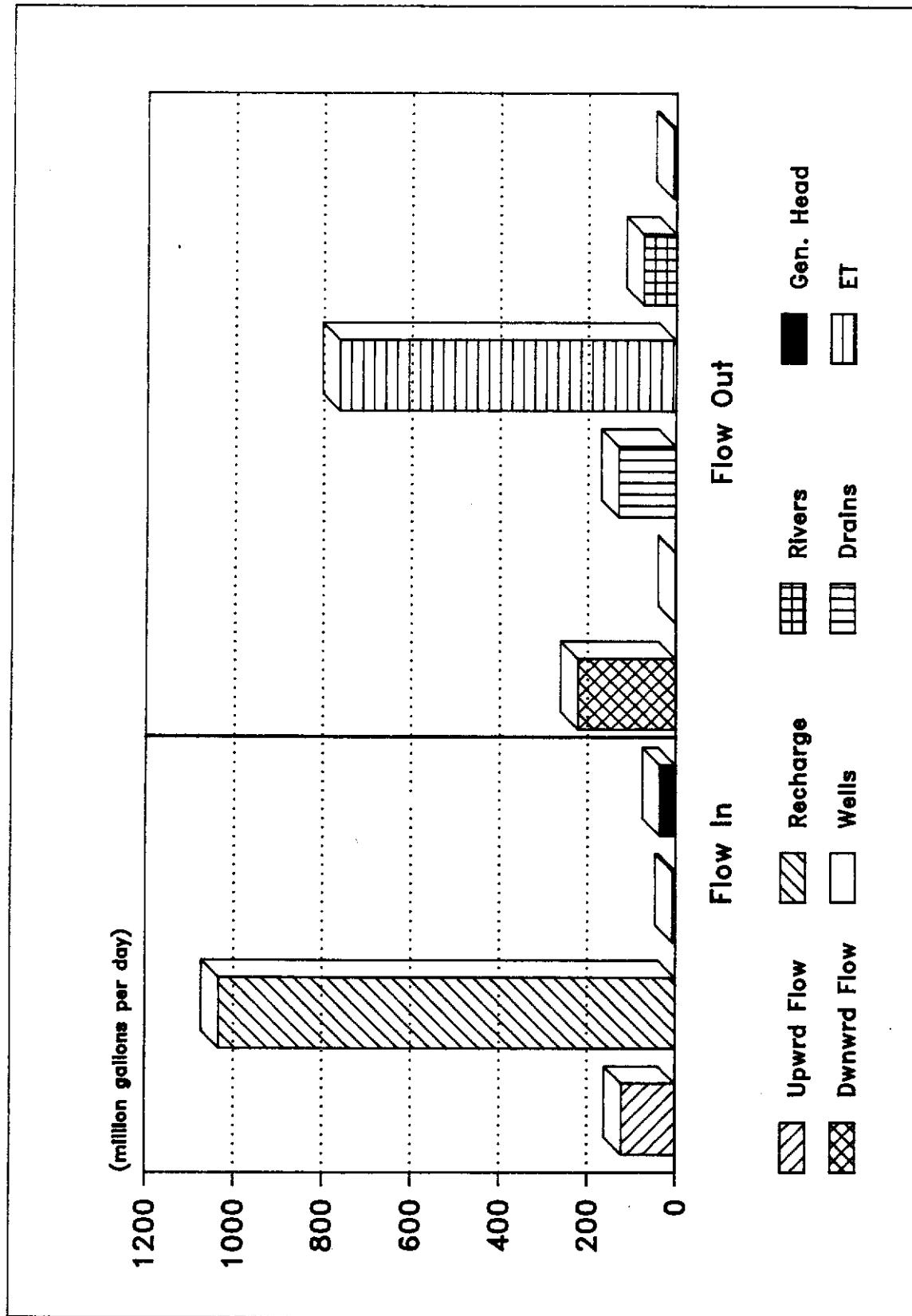


FIGURE 36. Volumetric Budget, Layer 1, Steady State

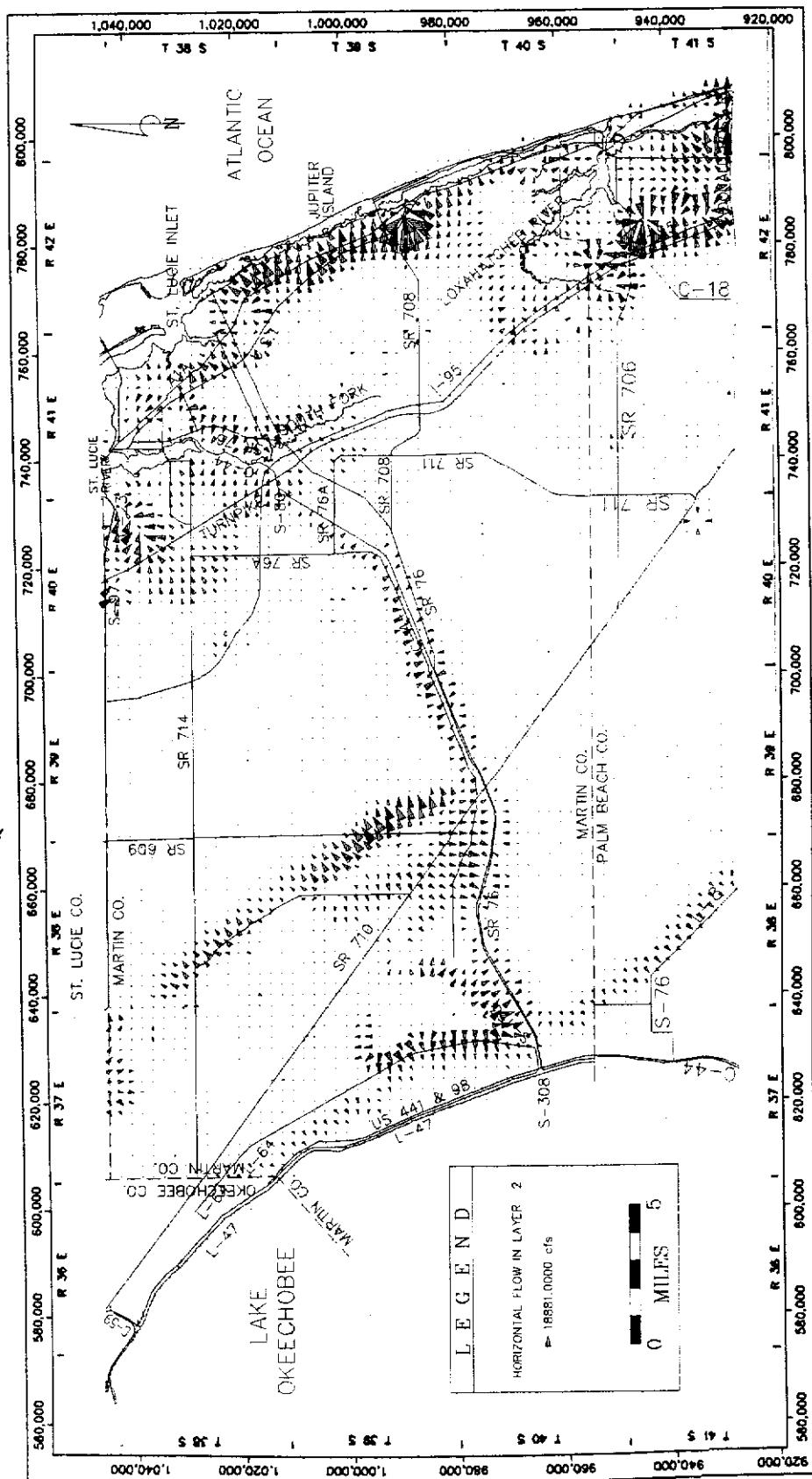


FIGURE 37. Magnitude and Direction of Horizontal Flow in Layer 2, Steady State

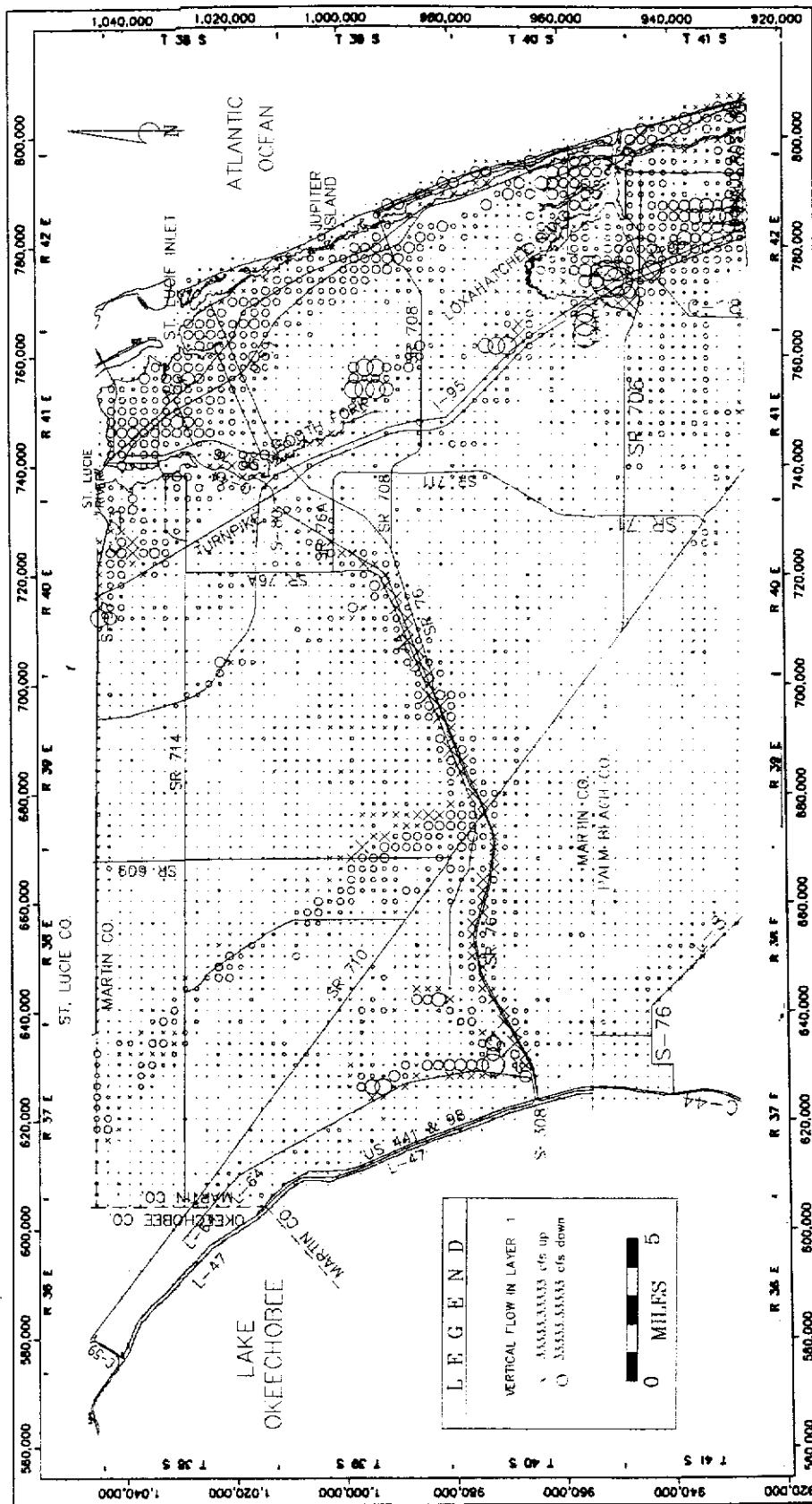


FIGURE 38. Magnitude of Vertical Flow Between Layer 1 and Layer 2, Steady State

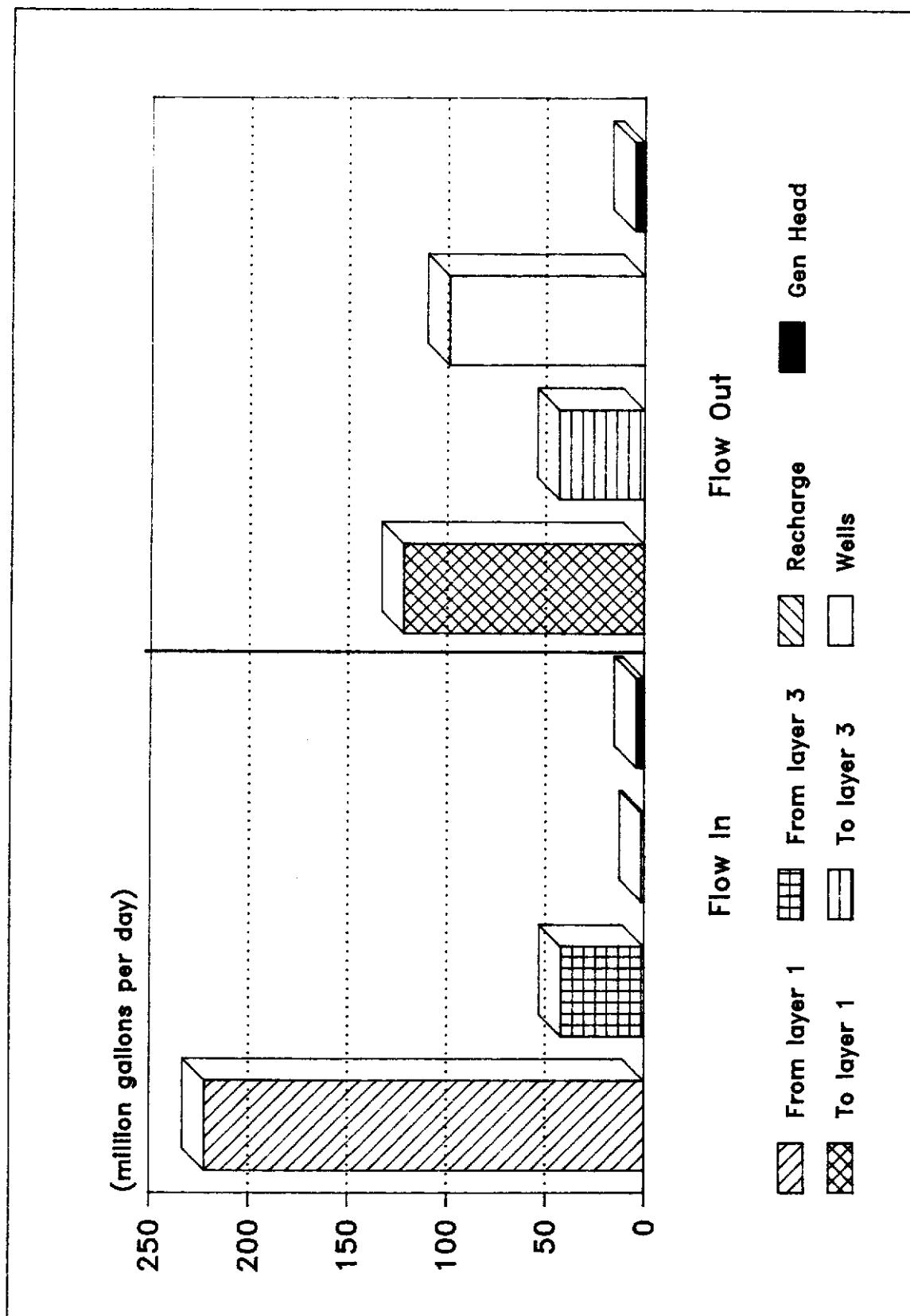


FIGURE 39. Volumetric Budget, Layer 2, Steady State

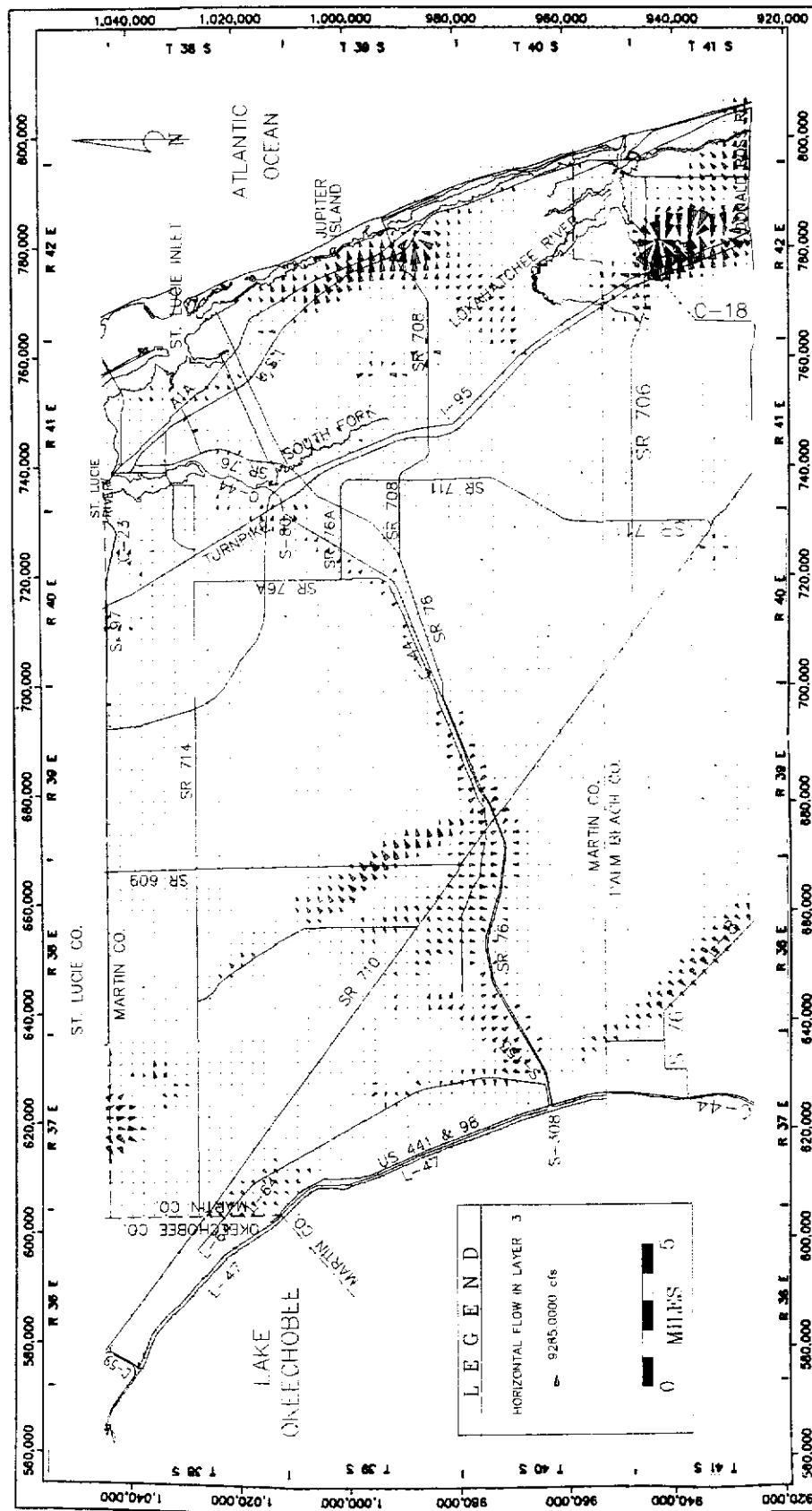


FIGURE 40. Magnitude and Direction of Horizontal Flow in Layer 3, Steady State

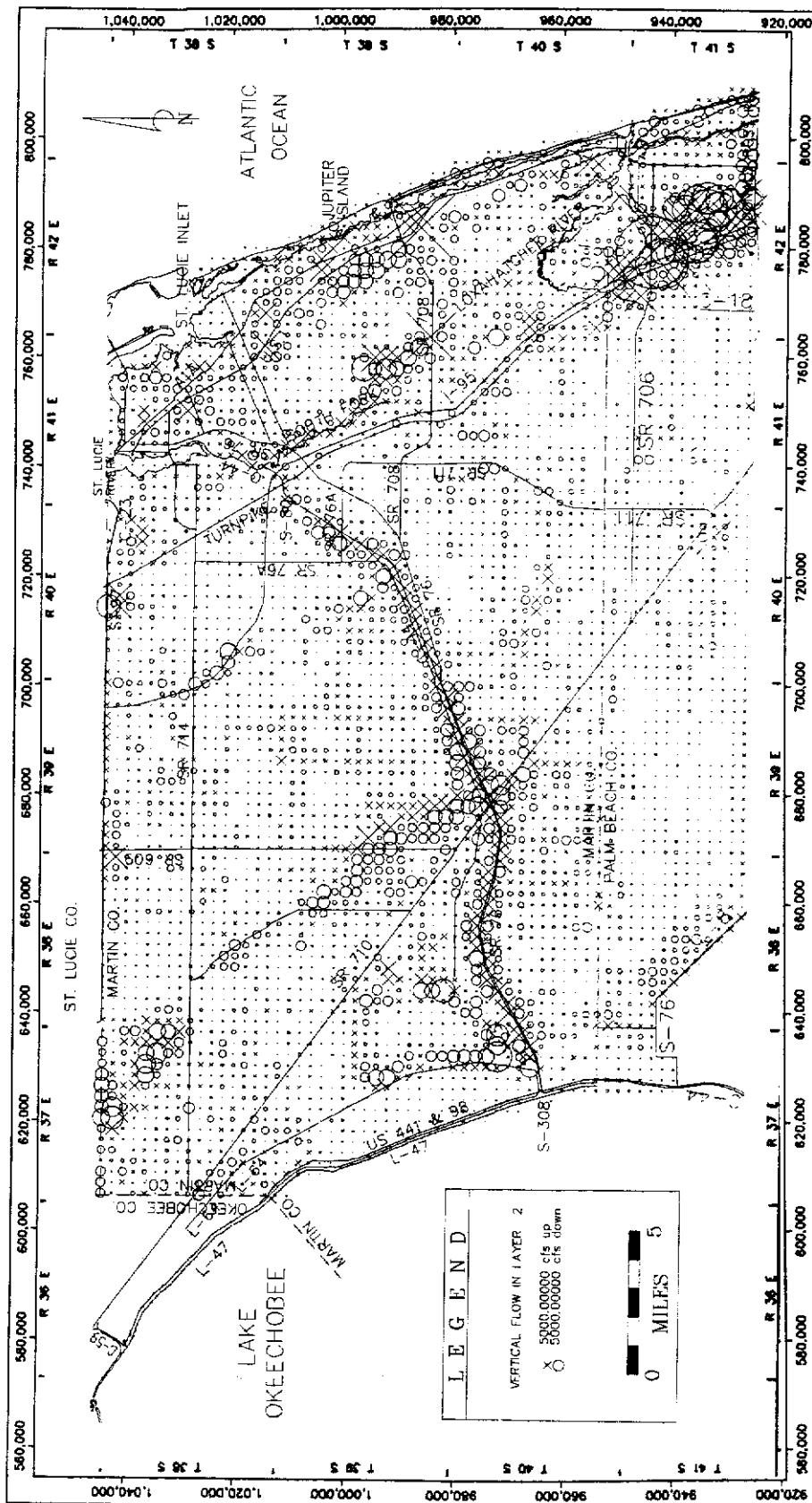
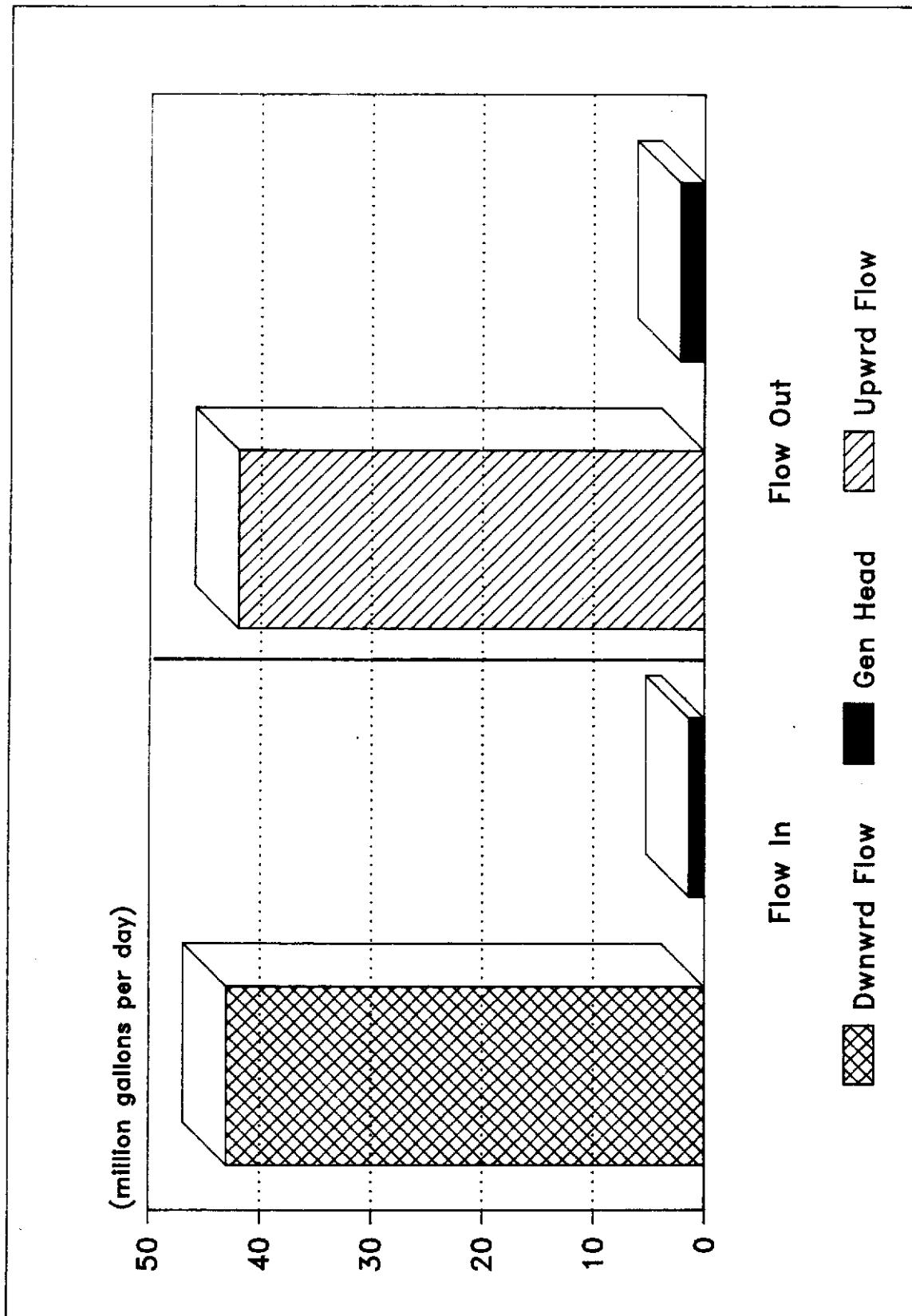


FIGURE 41. Magnitude of Vertical Flow Between Layer 2 and Layer 3, Steady State



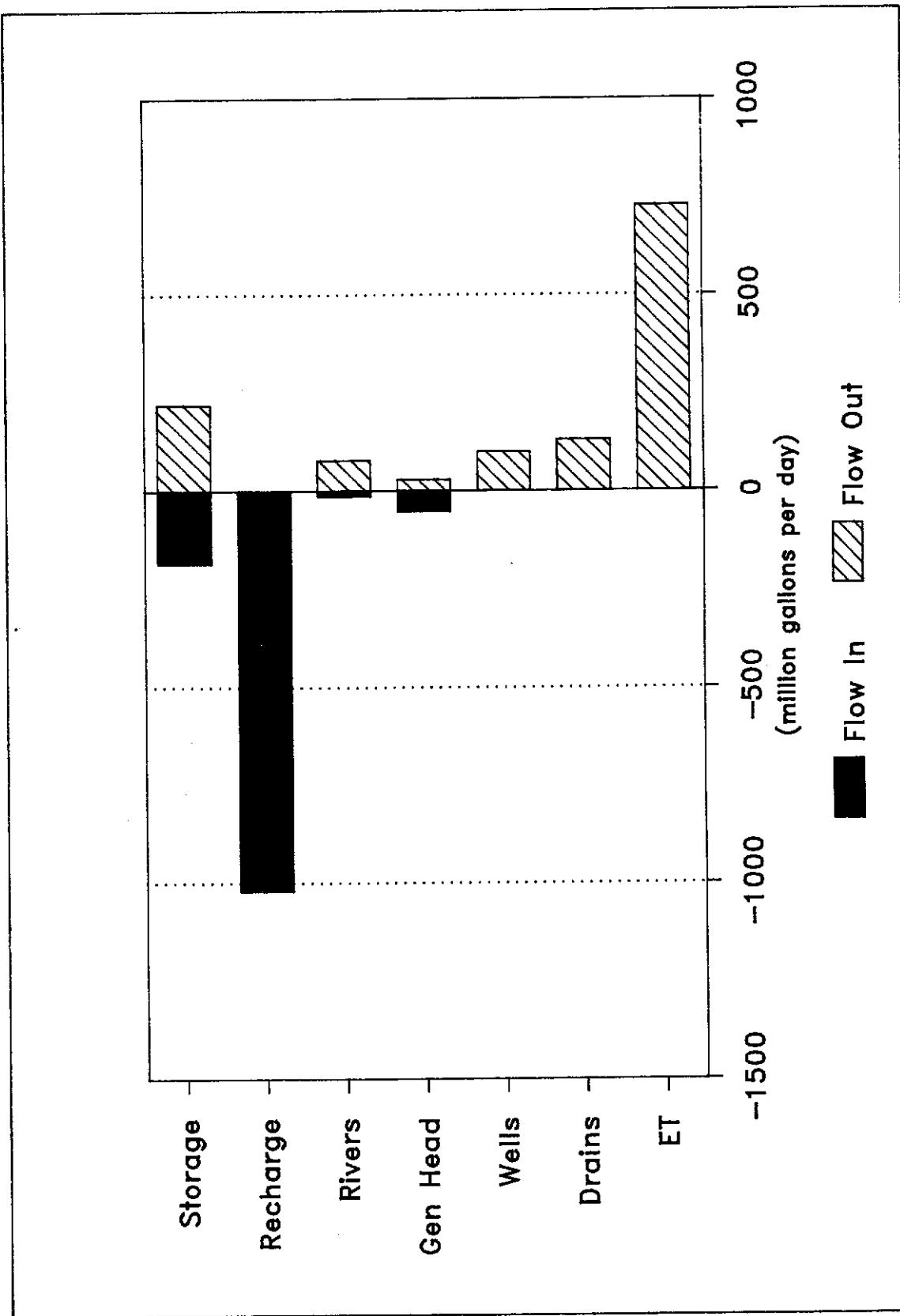


FIGURE 43. Volumetric Budget for Entire Model, Transient

**TABLE 8. VOLUMETRIC BUDGET FOR ENTIRE MODEL,
1989 CONDITIONS**

	RATE (Million Gallons/day)	RATE (Acre-Feet/day)
<u>IN</u>		
Storage	183	562
Constant Head	0	0
Wells	0	0
Drains	0	0
Recharge	1020	3130
ET	0	0
River Leakage	13.7	42
Head Dept. Bounds	52.8	162
Total In	1270	3898
<u>OUT</u>		
Storage	219	672
Constant Head	0	0
Wells	98.7	303
Drains	129	396
Recharge	0	0
ET	726	2228
River Leakage	77.6	238
Head Dept. Bounds	27.8	85
Total Out	1273	3907
IN-OUT	-2.93	-8.99

SENSITIVITY TESTING

The model was tested to check its sensitivity to changes in aquifer parameters and stresses. Using the steady state model, aquifer parameters were tested by altering the following parameters: Layer one conductivity and river and drain bed conductance, V_{cont} between layers one and two, layer two transmissivity, V_{cont} between layers two and three, and layer three transmissivity. The sensitivity of the model to these parameters was tested by doubling, then halving each parameter, one at a time. In addition, the V_{cont} terms and river and drain conductances were also reduced and increased by an order of magnitude. Using the transient model, specific yield in layer one was doubled and halved and storage in layers two and three were each increased and decreased by one order of magnitude. It was assumed that testing this range of values would bracket the range of uncertainty for each parameter. Head changes in each layer were examined to determine the relative sensitivity. The results of these tests are presented in Table 9.

The model was also tested, using the steady state version, for its sensitivity to the following climatological factors: recharge, maximum evapotranspiration rate, and evapotranspiration surface. Recharge and ET rates were increased and decreased by 10 percent, and the ET surface was raised and lowered by one and two feet. The wells were turned off for one scenario to see the overall effect of withdrawals. Using the transient model, starting head was increased and decreased by 2 feet and results after one stress period (one month) were analyzed. It was assumed that testing this range of values for the various stresses would bracket the range of uncertainty. Results of these sensitivity tests are presented in Table 10.

LAYER ONE

Generally, simulated water levels in layer 1 were not sensitive to changes in aquifer parameters. Changes in hydraulic conductivity in layer one, on average, had no effect with a maximum increase of a foot and maximum decrease of 0.71 feet. Doubling and halving the V_{cont} between layers one and two also had no effect but reducing it by an order of magnitude raised water levels by an average of 0.08 feet. An attempt to increase by V_{cont} an order of magnitude was unsuccessful as the model failed to converge. In layer two, the magnitude of the effect was similar but the direction was opposite with

water levels decreasing an average of 0.64 feet when the V_{cont} was reduced by an order of magnitude. Reactions in layer three were similar to those in layer two. Reducing specific yield by half led to a 0.12 foot average reduction in water levels while doubling it had no effect, on average. Since the maximum increase and decrease resulting from specific yield changes was over two feet, this parameter could affect calibration in some areas. These maximum and minimum values occurred in the Jupiter agricultural area north of Indiantown Road. The largest effects are usually seen in areas with the largest stress. This area has significant withdrawals and since the irrigation is by flood method, the recharge to the aquifer is also high. Therefore, changes in specific yield and storage have the greatest effect in this area.

As expected, increases in river and drain conductances resulted in lowering water levels in layer one, and average results in layers two and three were identical but the maximum change in water levels was slightly less in layer two and further diminished in layer three. A decrease in river and drain conductances led to a slight average increase in water levels, and layers two and three showed similar average changes. Of all the sensitivity runs made, changes in river and drain conductances had the largest maximum increase or decrease depending on the scenario. A decrease of almost twenty feet occurred in the Jupiter area when river and drain conductances were increased by an order of magnitude. The Jupiter area is the area of highest stress in the model, so the effect of changes is largest here also. The average value gives a better indication of the overall effect on the model, since most areas are not as significantly stressed.

LAYER 2

Simulated heads in layer 2 show only minor effects from changes in aquifer parameters. Average heads in layer two increased 0.01 feet when transmissivity was doubled and decreased 0.05 feet when transmissivity was cut in half. A maximum increase of almost six feet and a decrease of seven feet indicates that calibration in local areas could be significantly affected by transmissivity values. These maximum increases and decreases occurred in the area of the Jupiter wellfield. Changes in V_{cont} between layers two and three caused little or no average changes in water level in all three layers.

TABLE 9: Sensitivity Responses to Changes in Conductivity/Transmissivity, Storage, and VCONT (Head Changes in Feet)

Layer In Which Change Made	Parameter Changed	Layer 1				Layer 2				Layer 3			
		Max Incr	Ave Decl	Stand Change	Stand Dev	Max Incr	Ave Decl	Stand Change	Stand Dev	Max Incr	Ave Decl	Stand Change	Stand Dev
Layer 1	Conductivity * 2	0.99	-0.83	-0.01	0.09	0.96	-0.82	-0.01	0.09	0.94	-0.82	-0.01	0.09
	Conductivity * .5	0.57	-0.71	0.00	0.05	0.56	-0.67	0.00	0.05	0.55	-0.66	0.00	0.05
	Layer 1-2 VCont * .1	3.35	-1.24	0.08	0.29	1.88	-2.90	-0.04	0.24	1.83	-2.84	-0.04	0.23
	Layer 1-2 VCont * .5	0.39	-0.17	0.01	0.04	0.31	-0.78	0.00	0.03	0.30	-0.77	0.00	0.03
	Layer 1-2 VCont * 2	0.61	-0.20	0.00	0.03	2.62	-0.17	0.01	0.08	2.58	-0.16	0.01	0.08
	Riv & Drn Cond * 2	0.98	-3.37	-0.23	0.41	0.90	-3.34	-0.23	0.40	0.87	-3.32	-0.23	0.40
	Riv & Drn Cond * .5	3.57	-1.14	0.18	0.35	3.52	-1.06	0.18	0.34	3.49	-1.03	0.18	0.34
	Riv & Drn Cond * 10	1.95	-19.97	-0.74	1.24	1.90	-18.52	-0.74	1.22	1.81	-17.93	-0.74	1.21
	Riv & Drn Cond * .10	7.30	-4.44	0.44	0.90	7.12	-4.16	0.44	0.88	7.07	-4.05	0.44	0.88
	Specific Yield * 5	0.81	-2.45	-0.12	0.21	0.80	-2.41	-0.12	0.20	0.79	-2.39	-0.12	0.20
	Specific Yield * 2	2.17	-1.01	-0.01	0.20	2.12	-0.99	-0.01	0.19	2.10	-0.98	-0.01	0.19
Layer 2	Transmissivity * 2	5.85	-2.32	-0.05	0.39	5.86	-2.33	-0.05	0.40	5.76	-2.32	-0.05	0.40
	Transmissivity * .5	2.25	-7.08	0.01	0.41	2.26	-7.08	0.01	0.41	2.25	-6.96	0.01	0.41
	Layer 2-3 VCont * 2	0.05	-0.03	0.00	0.00	0.05	-0.03	0.00	0.00	0.09	-0.12	0.00	0.01
	Layer 2-3 VCont * 10	0.78	-0.05	0.00	0.03	3.60	-0.05	0.00	0.10	3.60	-0.22	0.00	0.10
	Layer 2-3 VCont * .5	0.05	-0.10	0.00	0.00	0.05	-0.10	0.00	0.00	0.22	-0.17	0.00	0.02
	Layer 2-3 VCont * .1	0.31	-0.79	0.00	0.04	0.31	-0.80	0.00	0.04	1.31	-1.26	0.00	0.12
	Storage * .1	-0.01	0.00	0.00		-0.01	0.00	0.00		-0.01	0.00	0.00	
	Storage * 10	0.13	-0.04	0.00	0.01	0.13	-0.04	0.00	0.01	0.13	-0.04	0.00	0.01
Layer 3	Transmissivity * 2	3.82	-0.98	-0.01	0.19	3.82	-0.99	-0.01	0.19	3.94	-1.02	-0.01	0.20
	Transmissivity * .5	0.66	-3.16	0.00	0.14	0.67	-3.16	0.00	0.15	0.68	-3.25	0.00	0.15
	Storage * .1	-0.01	0.00	0.00		-0.01	0.00	0.00		-0.01	0.00	0.00	
	Storage * 10	0.13	-0.04	0.00	0.01	0.13	-0.04	0.00	0.01	0.14	-0.04	0.00	0.01

Note: Layer 1-2 VCONT * 10 failed to converge

**TABLE 10: Sensitivity Responses to Changes in Stress and Boundary Conditions
(Head Changes in Feet)**

Parameter Changed	Layer 1				Layer 2				Layer 3			
	Max Incr	Max Decl	Ave Change	Stand Dev	Max Incr	Max Decl	Ave Change	Stand Dev	Max Incr	Max Decl	Ave Change	Stand Dev
120% Recharge	4.17	0.45	0.40	4.15	-0.38	0.45	0.40	4.15	-0.37	0.45	0.39	
80% Recharge	-5.65	-0.52	0.60	0.80	-5.63	-0.52	0.59	0.77	-5.63	-0.52	0.59	
120% ET Rate	-1.05	-0.22	0.14		-1.03	-0.22	0.14		-1.03	-0.22	0.14	
80% ET Rate	1.79	0.33	0.23	1.76	-0.12	0.33	0.23	1.76	-0.11	0.33	0.23	
Extinct Depth + 2'	-1.63	-0.76	0.32		-1.81	-0.76	0.31		-1.80	-0.76	0.31	
ET Surface + 2'	4.03	1.48	0.64	8.65	1.48	0.68	8.56	1.48	0.68	8.56	0.68	
ET Surface - 2'	-2.09	-1.55	0.59		-2.56	-1.55	0.59		-2.55	-1.55	0.58	
Wells Off	17.69	0.37	1.29	17.73	0.38	1.31	17.47	0.38	1.31	17.47	0.38	
Starting Head + 2'	2.01	1.50	0.42	2.01	1.50	0.41	2.01	1.50	0.41	2.01	1.50	
Starting Head - 2'	-2.01	-1.60	0.43		-2.01	-1.60	0.42		-2.01	-1.60	0.42	
General Heads + 2	2.0	.13	.39	2.0	.13	.39	2.0	.13	.39	2.0	.13	.39
General Heads -2	-2.0	-.12	.38		-2.0	-.13	.38		-2.0	-.13	.38	
General Heads Conductance * .1	1.52	-6.18	-0.06	.40	1.59	-6.18	-0.06	.40	1.61	-6.18	-0.06	.40
General Heads Conductance *10	5.42	-2.02	.03	.28	5.28	-2.03	.03	.28	5.25	-2.03	.03	.28

Note: Extinction Depth - 2 feet failed to converge

Changes in storage had no effect on average, with a maximum increase of 0.13 feet when storage was increased by an order of magnitude; this increase occurred in the Jupiter agricultural area near I-95 and north of Indiantown Road.

LAYER 3

Doubling and halving transmissivity in layer three resulted in almost no change in average water levels in layer three. Average effects in layer one and two were less than 0.2 feet, with a maximum rise in head of almost 4 feet when transmissivity was doubled and a maximum decrease in head of approximately 3 feet when transmissivity was reduced to half. Once again, the maximum increase and decrease occurred in the Jupiter wellfield area as a result of the large stresses in the area.

MODEL BOUNDARIES

The heads and conductances in the general heads were varied to determine their contribution at model boundaries (see Table 10 for results). At the Atlantic Ocean and Lake Okeechobee boundaries, because of the prescribed head condition, when prescribed head levels were increased or decreased by two feet, water levels in the cell containing the prescribed head also changed by the same amount. Along Lake Okeechobee, the cell adjacent to the prescribed head cell showed only a 0.1 foot change. However, along the ocean boundary, up to six cells west of the boundary were affected by the prescribed head level change. By the third or fourth cell west, the change was only 0.1 or 0.2 feet. The magnitude and distance of these effects was larger near coastal wellfields. Changes in the general head cells in layers two and three were similar to those in layer one. With an increase in prescribed head water level, flow increased into the model through the prescribed heads. There was no change in head as a result of reducing or increasing conductance by one order of magnitude. Flow rates out of the prescribed heads decreased only slightly with decreasing conductance and vice-versa. Flow rates were an order of magnitude less in layers two and three with an order of magnitude decrease in conductance. Similarly, increasing conductance in the general head boundary cells in layers two and three increased flow rates by approximately an order of magnitude.

Along the north model boundary, a two foot increase in general heads resulted in heads that were 0.8 feet higher in the boundary cells in all three layers. In boundary cells containing or directly beneath rivers, aquifer head levels increased up to

0.3 feet. The largest changes occurred near large gradients (Osceola Plain edges, S97 control structure). The change was 0.1 foot or less by the adjacent cell (Row 2). Reviewing flow rates into and out of the general head, the increased head reduced the rate of loss from the aquifer into the general heads or increased the rate into the aquifer from the general head, depending on the initial flow condition. Decreasing general heads by two feet reduced heads in the cell by one foot and 0.3 feet in the boundary cells containing rivers. Decreasing conductance by one order of magnitude reduced water levels by 0.7 feet in general head boundary cells and boundary cells containing drains. Water levels changed 0.1 foot or less in boundary cells containing rivers. The changes were insignificant in the adjacent cells in row two. Increasing conductance lowered water levels in the general head boundary cells by 1.1 feet. Changes in boundary cells containing rivers varied from +0.6 to -1.5 feet and averaged +.12 feet. In row two, changes were down to -0.3 feet and were -0.1 feet by row three. In boundary cells containing drains, however, water levels were one foot higher and by row four they were 0.1 feet higher than the initial heads. Effects of conductance changes were similar in all layers.

Along the south model boundary, the results of general head changes were similar in all three layers. When general head levels were increased by two feet, water levels in the boundary cells increased. In the area east of the Turnpike, near the Jupiter wellfield and nearby agricultural operations, water levels in the boundary cells were 1.26 feet higher in layer one and 1.33 feet higher in layers two and three. Water levels were affected up to six cells north of the boundary (Row 54). West of the Turnpike, water levels were 0.8 feet higher in the boundary cells but in the adjacent cells (Row 58), water levels were only 0.1 feet higher. Increases in flow rates out of the general head cells were less than one order of magnitude. Decreasing the general head water levels by two feet resulted in equal but opposite changes from the two foot head increase. An order of magnitude increase and decrease in general head conductance had variable results. West of the Turnpike, changes due to decreased conductance ranged from +0.5 feet to -0.4 feet with an average of -0.1 feet; while east of the Turnpike, changes ranged from -6.2 feet to +1.5 feet with the largest declines near pumpages. With increased conductances, changes west of the Turnpike ranged from -1.0 to +0.8 with an average increase of +0.2. East of the Turnpike, changes ranged from +2.8 feet to -1.2 feet with the higher increases near large ground water

withdrawals, and water levels were affected as much as five cells to the north (Row 54).

CLIMATOLOGICAL AND STARTING HEAD EFFECTS

Changes in these parameters (recharge, ET, starting head) showed some of the largest average changes in water levels in the model. Increasing and decreasing recharge by 20 percent resulted in a half foot increase and decrease in water levels, respectively. The maximum increase of 4 feet and decrease of 5.6 feet occurred in the Stuart area. Increasing the ET rate by 20 percent reduced water levels an average of 0.22 feet while decreasing the ET rate increased water levels by 0.33 feet on average. The maximum changes occurred in the area of the Florida Power and Light Reservoir. Increasing the extinction depth, which effectively increases the water available for ET, led to decreases in water levels of 0.76 feet. An attempt to reduce the extinction depth, adjusting so the minimum depth was zero feet, made the model unstable and it would not converge. Changes in the ET surface led to some of the most significant effects on average water levels. Increasing the ET surface by two feet, effectively moving it further away from the ground water source, led to an average water level increase

of 1.48 feet. Decreasing the ET surface had the opposite effect, with a 1.55 foot decrease in water levels, on average.

Starting head was another parameter that was increased and decreased by two feet using the transient simulation with very similar average results to ET surface changes. Raising and lowering the starting head is very similar to raising and lowering the ET surface and both should have similar effects. However, the model will attempt to equilibrate the water levels, moving them up or down based on the regional gradient. In lower transmissivity aquifers, model adjustments to equilibrate are slow and may not occur within the modeled time period. Therefore, starting head values should be as accurate as possible so calibration is not affected.

As a check of the effect of wells on the system, they were turned off for one sensitivity run. Predictably, the largest rise in water levels occurred in the Jupiter wellfield and was almost 18 feet, which is consistent with wellfield drawdown data. The overall average water level increase was only 0.37 feet, which reflects the fact that in the majority of the county, well use is small to none.

QUALITY ASSURANCE / QUALITY CONTROL PROCEDURE

The South Florida Water Management District developed a quality assurance/quality control (QA/QC) procedure pertaining to ground water flow models as they progressed from the development stage to use by the Planning Department. The process involves a series of iterations between the model developer and the end user in the Planning Department as well as a peer review team selected for each model.

Each model is evaluated in terms of: a) acceptability and b) impacts of deficiencies on application of the model. Acceptability is divided into three categories: 1) meets all standards of completeness and accuracy, 2) meets main standards, but enhancements are necessary to improve the overall accuracy of the model, and 3) does not meet standards and the model is not ready for use. All parameters that did not meet standards were corrected as a first priority. Parameters needing enhancements were prioritized into those that should be upgraded before the models are used to minimize future problems and those items which can be continually enhanced even while the model is in use.

The QA/QC checklist is divided in two parts; a conceptualization section and a data sets section. The conceptualization section is a narrative discussion of the methodology and assumptions used in creating the data sets. It covers such topics as boundary conditions, time and space discretization, recharge and evapotranspiration calculations, water use data sources and assumptions, aquifer

parameters, creation of parameters for rivers and drains, and calibration criteria. This discussion was intended to familiarize the user with all assumptions used in creating the model to make them aware of situations which may affect results. The data set checklist includes all data sets used in the model and verifies that there are no data anomalies. Data were checked both graphically and numerically. Three-dimensional plots of all arrays were created to point out errant data points. Contour plots were compared with data points used to create them to make sure they were accurate. The minimum and maximum value for each plot was determined and checked for reasonableness. Numeric arrays were printed and checked visually, especially at boundaries. River, drain and general head cell values were also printed spatially and checked for reasonableness and consistency between cells. All well locations were verified both in row, column and planar coordinate formats. Modeled pumpage was compared to permitted allocations for reasonableness. The volumetric budget was also checked to determine if anything was out of proportion.

Several data corrections were made and changes in conceptualization at boundaries and in recharge and evapotranspiration sections resulted in model modifications. Finally, agreement was reached and checklists from the peer review panel were approved with no unacceptable sections and several sections identified as acceptable under current conditions with future enhancements necessary.

RESULTS

1. The most important source of recharge to the Surficial Aquifer System in Martin County is rainfall. Approximately 95 percent of the recharge in the study area was provided by rainfall. The remaining five percent came from ground water flow into the modeled area (four percent) and river leakage (one percent).
2. Evapotranspiration accounts for the majority of outflow from the modeled area (approximately 70 percent). The remaining outflow is comprised of well withdrawals (nine percent), ground water flow out of the modeled area (one percent), and discharge to surface water bodies (19 percent).
3. Forty-five percent of the total ground water well withdrawals in the model area come from domestic self-supply use. Agricultural irrigation accounted for 27 percent of the ground water well withdrawals and public water supply withdrawals accounted for 24 percent. The remaining four percent comes from industrial uses.
4. The largest impacts in layer one, based on flow volumes, occur in the Port Salerno area, where domestic self-supply use is high, and at the edge of the Osceola Plain in Indiantown, where ground water elevations decrease rapidly and are further reduced by grove drainage. In layer two, flow is greatest around the Hobe Sound and Jupiter wellfields. Flow is also greatest around the Jupiter and Hobe Sound wellfields in layer three as well as between layers two and three.

CONCLUSIONS AND RECOMMENDATIONS

1. Discharge to surface water bodies accounted for 19 percent of losses from the ground water system. Currently, the accuracy of this number cannot be verified but surface water models are being developed and results from this may result in modifications to the ground water model. One potential for error comes from defining the "wetted perimeter" of a canal. Data on widths and depths of canals is sparse, especially for the many grove and roadside drainage canals. Also, these same canals have no records on stage levels and often, not even information on control structure elevations. This makes it difficult, if not impossible, to accurately represent the drainage and recharge potential of these surface water bodies. During the regulation process, every effort should be made to include pertinent control elevation and canal construction data in the permits. Information concerning ditches, lakes, canals, wetlands, etc. in future surface water permits as well as one foot topographic data obtained during permit review could be of benefit in model calibration. Stage recorders in some of the major grove canals would produce invaluable data for use in the ground and surface water models.
2. Currently, the model is not sensitive/accurate enough to be used in surface water permitting to determine exact control elevations or to set wetland elevations. However, ground water levels in the model can be checked against existing permits and new proposed control elevations and any discrepancies reported to the model developer to aid in improved model calibration. Refinements in grid size and elevation data would make this a useful tool for surface water permitting to evaluate existing and future impacts due to surface water management systems.
3. The model in its present configuration (92 acres per cell) is not accurate in assessing ground water withdrawal impacts on a small scale, due to the regional nature of the model grid. As a result, small scale impacts on adjacent users or small wetland areas may be overlooked due to cell-wide averaging. Improved grid resolution and use of one foot topographic data is needed to better assess these small scale impacts. The SFWMD is currently working on software to make it possible to "zoom in" on an area of the regional model and extract data to create a submodel with finer grid resolution. This should improve site-specific evaluations.
4. With 95 percent of water to the model coming from the recharge package and 70 percent of the losses removed by the evapotranspiration package, the accuracy of the model is dependent on the accuracy of these two packages. During model calibration it became very obvious that these packages do not allow the user to accurately imitate the intricacies of these processes because they deal only with direct effects on the saturated aquifer. Therefore, pre-processing of inputs to these packages is necessary to meet the assumptions the model makes of this data. Areas needing work include accounting for irrigation water, investigating areas where ground water is significantly below land surface (dunes), and effects of canals which lower the water table below the ET extinction depth and the effects of each of these situations effects on recharge and evapotranspiration rates.
5. One portion of the evapotranspiration package is ET surface. It is usually set to land surface. Detailed land surface data on a large scale is not available. Where water level data were available for confirmation, changes of even one foot in ET surface affected calibration results. This illustrates the need for detailed information. However, cell size is also an important factor. In areas with rapid elevation changes, smaller cells and more detailed data should result in improved calibration of the model.
6. Although ground water withdrawals account for only nine percent of the modeled outflow, the impact of these withdrawals was the impetus for developing the model. Because domestic self-supply is such a large and widespread type of water use, parameters used in reaching this estimate need refining to increase the accuracy and reliability of the model. Specifically, better information on where all domestic use is self-supplied (i.e. pockets not yet on utilities), the location of private wells in utility areas and/or homes which use utility water for irrigation is needed.

Agricultural irrigation accounted for 27 percent of the ground water well withdrawals in Martin County. However, data on actual amounts withdrawn are limited. Actual water use data would increase confidence in the calibration of the model, particularly in areas of heavy ground water use. In addition, accurate projections of future agricultural water use will be necessary for the development of a water supply plan for the area including Martin County. Most public supply utilities do not record flow from individual wells in their wellfields. Some do keep track of hours pumped per well but point out that well capacity is dependent on the

number of wells pumping at a given time, which changes often. Individual flow meters would provide accurate withdrawals for input into the model.

7. The model was difficult to calibrate within the specified constraints in several localized areas, especially the Martin Downs/Palm City area. Probable reasons are cell-wide averaging or uncertainty in aquifer parameters or stress rates. Future revisions to the model should be concentrated in these areas to improve the confidence level of the model.

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APPENDIX A

**MAPS AND TABLE OF DATA USED
FOR VERTICAL DISCRETIZATION**

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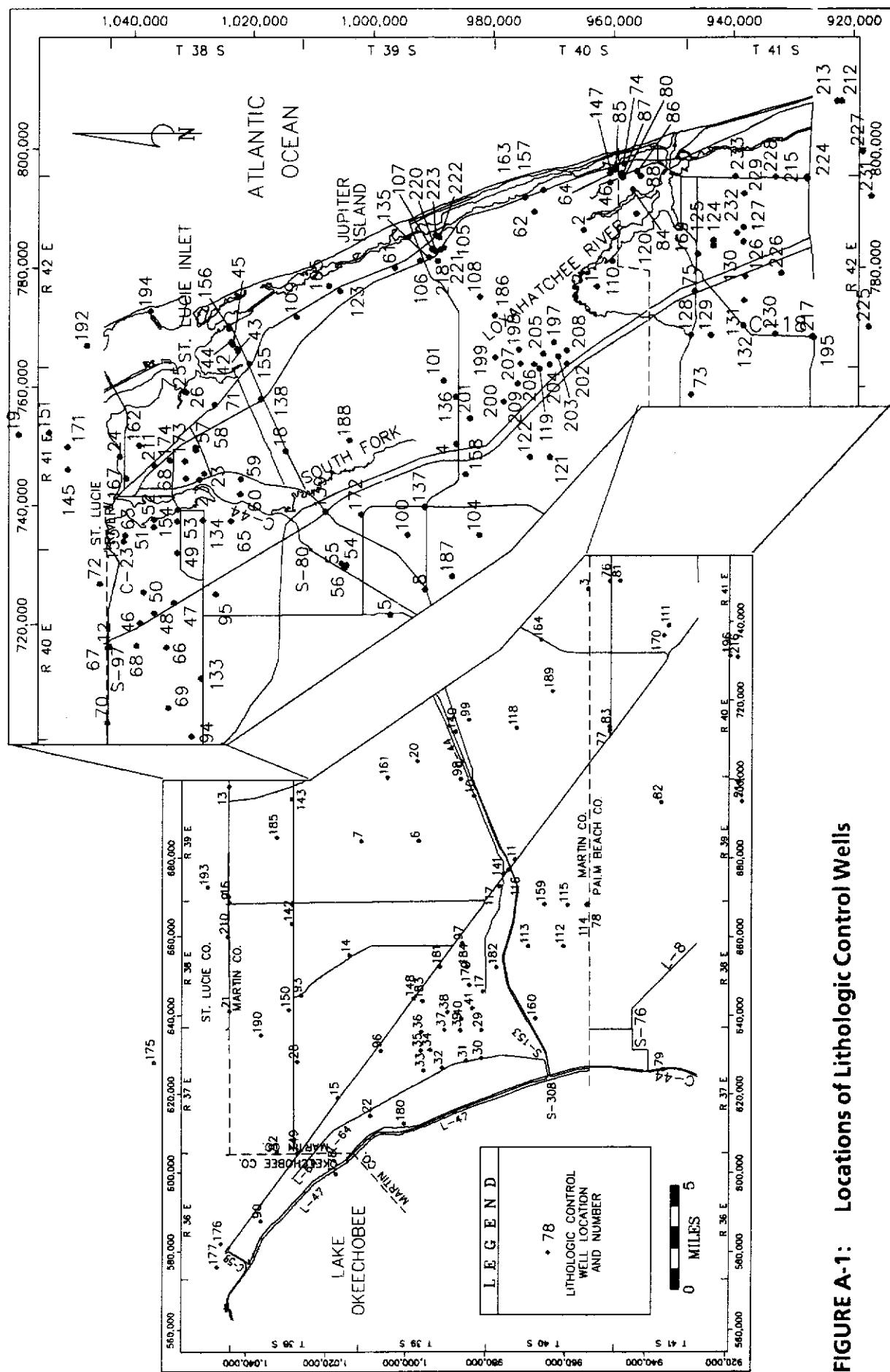


FIGURE A-1: Locations of Lithologic Control Wells

TABLE A-1: Lithologic Well Data

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
1	M1229	776748	962488	10	22	99	30	-12	-111	-141
2	M1230	786233	964674	8	25	109	0	-16	-125	
3	M1231	748150	954250	22	15	115	40	7	-108	-148
4	M1235	750277	985847	17	38	24	88	-21	-45	-133
5	M1236	721553	996890	25	18	67	45	7	-60	-105
6	M1237	684311	996504	27	15	83	52	12	-71	-123
7	M1238	684246	1010943	27	15	44	67	12	-32	-99
8	M1239	725834	991057	23	15	47	65	8	-39	-104
9	M1240	668568	1043894	30	15	36	80	15	-21	-101
10	M1241	695767	982723	35	17	86	53	18	-68	-121
11	M1242	679626	972350	26	37	28	101	-11	-39	-140
12	M1246	716250	1043800	22	18	112	21	4	-108	-129
13	M1248	697980	1044050	31	39	43	75	-8	-51	-126
14	M1250	655300	1013870	45	46	64	41	-1	-65	-106
15	M1251	619000	1016650	31	23	27	88	8	-19	-107
16	SCD2	670000	1044150	30	15	42	71	15	-27	-98
17	M1252	646150	980450	25	18	44	83	7	-37	-120
18	M1253	749150	1014400	17	40	95	15	-23	-118	-133
19	M1254	751850	1059150	15	40	90	38	-24	-114	-152
20	CAULKINS	704550	996900	27	15	60	70	12	-48	-118
21	C-23	641000	1043900	26	20	90	10	6	-84	-94
22	L-65	614400	1008600	20	20	40	60	0	-40	-100
23	SR76	745300	1028000	10	40	120	20	-30	-150	-170
24	SITEA	748200	1042100	10	38	47	46	-28	-75	-121
25	SITEH-A	759150	1031200	10	42	68	16	-32	-100	-116
26	SITEH-C	759000	1031000	10	55			-45		
27	SITEI	744300	1028750	10	26	100	21	-16	-116	-137
28	MF20	628260	1026880	32	23	21	97	9	-12	-109
29	CB-12	636350	980800	23	38			-15		
30	CB11	629250	980750	25	33			-8		
31	CB9	628600	984500	22	27	71		-5	-76	

TABLE A-1: Lithologic Well Data (Continued)

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
32	CB8	626750	990600	22	23			-1		
33	CB7	626000	995200	22	23	67		-1	-68	
34	CB13	631300	993550	25	22	70		3	-67	
35	CB6	631100	995900	26	25	65		1	-64	
36	CB5	635900	995800	27	23	53	48	4	-49	-97
37	CB4	636350	989950	26	22	75		4	-71	
38	CB3	640900	989200	27	26	76	48	1	-75	-123
39	CB2	636300	986000	23	20	80		3	-77	
40	CB10	639200	985800	23	20	82	43	3	-79	-122
41	CB1	641850	983000	24	15	84	35	9	-75	-110
42	MG1	766000	1022400	15	25	115		-10	-125	
43	MG2	766350	1022500	20	30	115		-10	-125	
44	MG4	767100	1023300	20	42	103		-22	-125	
45	MG5	767500	1023500	20	35	105		-15	-120	
46	MD-4D	720150	1038700	5	15	80	45	-10	-90	-135
47	MD-3D	723550	1033000	18	20	85	40	-2	-87	-127
48	OW-1D	721850	1036350	18	20	65	50	-2	-67	-117
49	MD-5D	731900	1032500	13	30	60	50	-17	-77	-127
50	MD-6D	725350	1038100	11	15	75	60	-4	-79	-139
51	MD-1D	736300	1036400	7	50	65	20	-43	-108	-128
52	MD-5S	737550	1036400	5	50	40	30	-45	-85	-115
53	MD-2D	737300	1032500	7	50	30	15	-43	-73	-88
54	SLF1	729400	1004500	20	22	54	49	-2	-56	-105
55	SLF2	729950	1004150	20	22	37		-2	-39	
56	SLF3	730200	1005000	20	23	45	59	-3	-48	-107
57	STTPW-1	749250	1029350	15	32	108		-17	-125	
58	ST0W-2	749700	1029400	15	40	100		-25	-125	
59	BBOW-1D	744400	1021850	3	30	100	30	-27	-127	-157
60	BBOW-4D	741900	1021950	10	60			-50		
61	HS32W	779850	996200	30	40	85	85	-10	-95	-180
62	M1093	789300	972900	7	35			-28		
63	WOODOBS	733850	1041450	10	41			-31		

TABLE A-1: Lithologic Well Data (Continued)

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
64	TEQPK	795900	960400	25	26			-1		
65	PL4	737350	1023500	12	35	45		-23	-68	
66	GDC1	716000	1034250	20	28	72		-8	-80	
67	GDC2	716000	1044000	20	35	69	46	-15	-84	-130
68	GDC4	716300	1039300	20	20	30		0	-30	
69	GDC5	705800	1033950	25	20	22	114	5	-17	-131
70	GDC8	703300	1044100	25	20	62	52	5	-57	-109
71	INTOBS	756900	1026250	15	50			-35		
72	HR2	726750	1045400	11	48	52	40	-37	-89	-129
73	JURB1	758600	946750	15	20	105		-5	-110	
74	PB597	797500	958100	21	15	50		6	-44	
75	PB639	775952	946225	16	40	92	86	-24	-116	-202
76	PB640	750140	948888	19	22	98	55	-3	-101	-156
77	PB649	712491	948777	26	24	31		2	-29	
78	PB650	668304	954126	7	21	101	71	-14	-115	-186
79	PB651	626285	935296	22	22	68	120	0	-68	-188
80	PB681	795146	958274	12	15	201		-3	-204	
81	PB1546	750247	946263	20	18	75	63	2	-73	-136
82	PB1613	694180	935863	26	15	76	70	11	-65	-135
83	PB1614	713305	948882	27	27	23	99	0	-23	-122
84	TEQRD1	793100	956600	10	30	110		-20	-130	
85	TEQD2-5	796500	959600	20	33			-13		
86	TEQD1-3	796200	955900	15	35	0		-20		
87	TEQD1-4	795900	958500	16	36	0		-20		
88	TEQD1-2	795400	955300	10	45	0		-35		
90	93836	587700	1036000	20	25	23		-5	-28	
92	Pioneer 133	605000	1032000	25	40	44		-15	-59	
93	TurnDairy	645000	1026000	35	50			-15		
94	StuartWest	701000	1030000	30	20	40		10	-30	
95	PalmCty23	725000	1026000	20	25			-5		
96	113937	631000	1006000	25	30			-5		
97	CAULK1	658300	985600	35	20	80	80	15	-65	-145

TABLE A-1: Lithologic Well Data (Continued)

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
98	CAULK4	700000	986000	27	30	110	30	-3	-113	-143
99	Burg&Div33	715000	984000	24	20			4		
100	193941	735000	994000	20	30	95		-10	-105	
101	PeroFarm2	761000	988000	15	20			-5		
104	Burg&Div31	735000	982000	20	20	40	80	0	-40	-120
105	H.S.Water	783249	988032	35	35			0		
106	H.S.Assoc	781000	992000	24	40			-16		
107	JBReedPk	783000	990000	25	30			-5		
108	Bridge&Flor	775000	982000	10	20	80		-10	-90	
109	HYD10	771700	1012600	20	30			-10		
110	Ju.RivDr.	781000	960000	10	30			-20		
111	PBPkCommS	739000	934000	24	15	83		9	-74	
112	CVII-5	657600	960200	27	15	70	100	12	-58	-158
113	CV11-4	657600	969000	27	15	90	60	12	-78	-138
114	CVI-5	668100	954400	24	15	90	80	9	-81	-161
115	CVI-4	668100	959200	24	20	55	105	4	-51	-156
116	Dunklin-Ind	677000	974000	30	52			-22		
117	IND3R	672764	976408	35	60	57		-25	-82	
118	Burg&Div 94	713000	972000	24	15	30	95	9	-21	-116
119	Becker 1240	763000	972000	15	20			-5		
120	Teq. 264042	789000	956000	8	20	82		-12	-94	
121	BECKB30-1	748100	970200	19	15			4		
122	BECKB30-2	748100	973500	19	15			4		
123	HYD1A	776025	1005343	25	23			2		
124	JU13	783667	943147	13	40	110		-27	-137	
125	JU14	784500	943150	13	40	88		-27	-115	
126	JU15	784300	938100	14	35	0		-21		
127	JU18	786700	938100	14	45	80		-31	-111	
128	GMRB1	768600	946800	15	40	85		-25	-110	
129	GMRB3	768600	943500	15	15	130		0	-130	
130	GMCE1	778500	937800	16	50	80		-34	-114	
131	GMCE2	774400	938000	16	30	140		-14	-154	

TABLE A-1: Lithologic Well Data (Continued)

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
132	GMCE3	770200	938100	16	20	110		-4	-114	
133	M1012	710814	1028439	24	20	80	40	4	-76	-116
134	M1013	737462	1028182	12	30	90	50	-18	-108	-158
135	M1014	781628	990500	25	30	130	70	-5	-135	-205
136	M1015	758234	985896	15	15	120	60	0	-120	-180
137	M1016	739757	991136	19	15	80	60	4	-76	-136
138	M1017	757938	1018511	15	30	130	30	-15	-145	-175
139	M1018	738937	1007691	12	20	80	50	-8	-88	-138
140	M1019	712020	987348	25	15	90	50	10	-80	-130
141	M1020	675904	975362	20	80	40	50	-60	-100	-150
142	M1021	663212	1028322	31	15	30	110	16	-14	-124
143	M1022	694916	1028461	30	20	50	80	10	-40	-120
145	M1030	745997	1050852	15	40	55	15	-25	-80	-95
146	M1038	794316	960388	13	20			-7		
147	M1039	796398	960302	25	35			-10		
148	M1040	644262	997757	30	15	90	70	15	-75	-145
149	M1041	604957	1026919	28	30	70	100	-2	-72	-172
150	M1042	641351	1029048	36	40	120	10	-4	-124	-134
151	M1043	752207	1054021	11	61	59	90	-50	-109	-199
153	M1050	734858	1041193	5	37	118	10	-32	-150	-160
154	M1051	739244	1032332	5	55	82		-50	-132	
155	M1052	763889	1020468	8	50	47	20	-42	-89	-109
156	M1053	769739	1023838	5	15	172	0	-10	-182	-182
157	M1070	792971	971386	21	27	208		-6	-214	
158	M1075	745223	984301	19	35	51		-16	-67	
159	M1085	668259	964930	24	18	72		6	-66	
160	M1088	639304	967144	24	15	72	58	9	-63	-121
161	M1089	700363	1004455	27	15	64		12	-52	
162	M1091	750043	1038860	12	43	112	27	-31	-143	-170
163	M1095	791774	974407	30	20			10		
164	M1096	735291	965764	22	24	40	82	-2	-42	-124
165	M1097	776898	1007224	10	20			-10		

TABLE A-1: Lithologic Well Data (Continued)

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
167	M623	744500	1041000	10	45			-35		
168	M841	744500	1031000	15	55	113	42	-40	-153	-195
169	JURO1	782200	945700	13	40	100	60	-27	-127	-187
170	PBPkCom	736400	935200	24	12			12		
171	SW-1	749789	1050875	5	60	50		-55	-105	
172	MPLCLUB	738500	1001800	15	50	85	20	-35	-120	-140
173	M1181	747400	1031150	15	41			-26		
174	M1189	747550	1033700	15	40			-25		
175	EVANS	628000	1062900	27	15	110	20	12	-98	-118
176	REDTOP	582000	1046000	25	30	58	15	-5	-63	-78
177	KINGSBAY	576000	1047000	20	40	25		-20	-45	
178	W5405	599650	1017200	17	22	78	59	-5	-83	-142
179	W14754	647750	983800	28	20	60	82	8	-52	-134
180	W15817	612500	1000100	15	30	88	11	-15	-103	-114
181	BTW-1	652354	991086	33	20	60	84	13	-47	-131
182	BTW-2	652258	977089	23	40	25	54	-17	-42	-96
183	BTW-3	643646	995507	31	31	44	83	0	-44	-127
184	BTW-4	652283	984402	31	30	50	85	1	-49	-134
185	ALLAPAPT	685200	1032100	30	15	32	108	15	-17	-125
186	JDSPAPT	771850	979525	12	30	90	102	-18	-108	-210
187	MONREVE	728050	986500	22	15	64	50	7	-57	-107
188	MOBIL	750900	1003700	13	60	60	50	-47	-107	-157
189	PALMAR	722320	963020	24	25	65		-1	-66	
190	EVANS	635000	1036000	30	45	45	70	-15	-60	-130
192	MF3	766873	1047651	6	60	10	75	-54	-64	-139
193	SLF-23	672337	1049363	30	21			9		
194	MF-4	772700	1037000	9	15	190	60	-6	-196	-256
195	PB-1607	768207	926382	18	35	99	35	-17	-116	-151
196	PB-1550	731213	918686	23	36	104	13	-13	-117	-130
197	HSP83-1	767400	969600	14	25	102		-11	-113	
198	HSP83-2	766150	975400	14	15	94		-1	-95	
199	HSP83-3	764850	979450	14	30	130		-16	-146	

TABLE A-1: Lithologic Well Data (Continued)

Map #	Well Name	State Plane Coordinates		Land Surface Elev.	Model Layer 1 Thick	Model Layer 2 Thick	Model Layer 3 Thick	Bottom Layer 1 Elev NGVD	Bottom Layer 2 Elev NGVD	Bottom Layer 3 Elev NGVD
		East	North							
200	HSP83-4	757400	978000	15	15	116		0	-116	
201	HSP83-5	754600	983600	15	15	140		0	-140	
202	HSP89-15	763800	967500	15	15	77		0	-77	
203	HSP89-16	765000	968900	15	15	85		0	-85	
204	HSP89-17	763700	970300	15	26	69		-11	-80	
205	HSP89-18	765500	971350	14	21	94	55	-7	-101	-156
206	HSP89-19	763700	972850	14	15	130		-1	-131	
207	HSP89-20	763800	975100	14	20	110		-6	-116	
208	HSP89-21	766050	967500	12	28	52		-16	-68	
209	HSP89-22	760450	975600	10	15			-5		
210	STLCH5	659808	1044364	26	15	18		11	-7	
211	TC21-44	746700	1036400	15	45	100		-30	-130	
212	PB708	807905	921812	18	25	100		-7	-107	
213	PB709	807899	922619	17	24	151		-7	-158	
214	PB830	694365	915669	22	15	40	112	7	-33	-145
216	PB1109	730861	916765	23	29	125		-6	-131	
217	PB1099	768387	926585	18	27	93	49	-9	-102	-151
218	HSMW4DL	781000	989000	40	30	131	71	10	-121	-192
220	HSMW2D	782750	989500	30	37	57		-7	-64	
221	HSSW4	782900	988600	35	44	71		-9	-80	
222	HSSW3	785000	988800	40	44	71		-4	-75	
223	HSSW1	785400	989400	7	20	61		-13	-74	
224	GMSC2	794900	927500	13	36			-23		
225	GMSC8	770000	917200	18	35	155	36	-17	-172	-208
226	GMSC11	779000	931800	18	50	72	22	-32	-104	-126
227	GMSC20	799500	918300	10	34	108	98	-24	-132	-230
228	GMSC22	795200	932800	10	23	225	130	-13	-238	-368
229	GMSC25	792400	938000	8	33	176	90	-25	-201	-291
230	GMSC31	768800	932800	18	39		24	-21		
231	GMSC33	791900	916800	14	40	125		-26	-151	
232	MPLWOOD	785750	939200	14	50	95	115	-36	-131	-246
233	GMJLTW2	795300	939500	6	53	102		-47	-149	

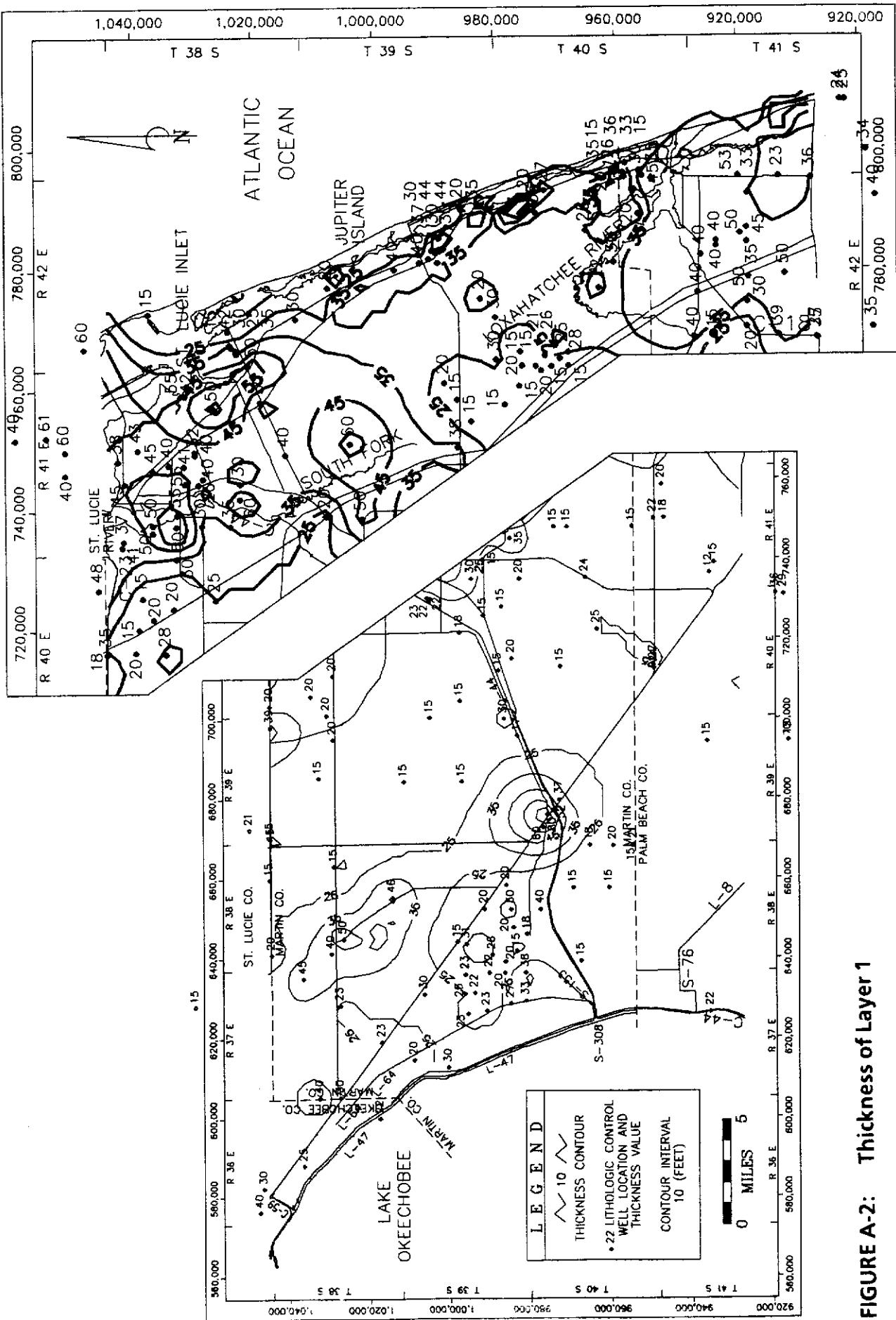
TABLE A-2: Source of Lithologic Data

Source	Development/Report	Map Number
SFWMD	Unpublished	1-23,82,83,185-188,210
Geraghty & Miller	City of Stuart	24-27
SFWMD	Tech Pub 84-2	28
FP&L	Martin Power Plant	29-41
Gee & Jenson	Miles Grant	42-45
Gee & Jenson	Martin Downs	46-53
Perrson Drilling Corp	St. Lucie Falls	54-56
CH2MHill	Stuart So. Wellfld	57,58
Gee & Jenson	Banyan Bay	59,60
USGS	Hobe Sound/Unpublished	61
USGS	J.D.S. Park/Unpublished	62
Geraghty & Miller	Woodside	63
USGS	Tequesta/Unpublished	64
CH2MHill	Pipers Landing	65
Geraghty & Miller	GDC-Martin Co.	66-70
Geraghty & Miller	Stuart Y & CC	71
Geraghty & Miller	Harbour Ridge	72
Geraghty & Miller	River Bend Pk	73
USGS	Open File Rpt 76-713	74-80
USGS	Unpublished	81,195,196
Gee & Jenson	Tequesta	84-88
Ray Domer, Driller	Okeechobee	90
Frank DeCarlo, Driller	Pioneer Estates	92
Ray Domer, Driller	Turnpike Dairy	93
Martin Co. Well Drilling	Stuart West	94
B.J. McCullers, Driller	Palm City	95
Dan Barrett, Driller	Indiantown	96
Steve Ordway, Driller	Caulkins Indiantown	97,98
D. Spencer, Driller	Burg & Divosta	99,104,118
Steve Ordway, Driller		100
Steve Ordway, Driller	Pero Farms	101
D. Spencer, Driller	Burg & Divosta	104
A.E.C.O.A., CH2MHill	Hobe Sound	105

TABLE A-2: Source of Lithologic Data (Continued)

Source	Development/Report	Map Number
Steve Ordway, Driller	Hobe Sound	106
Gordon Bearss, Driller	Hobe Sound	107
Steve Ordway, Driller	Hobe Sound	108
Steve Ordway, Driller	Hydratech	109
Donald Barrett, Driller	Tequesta	110
David Webb, Driller	PB Pk of Commerce	111
Steve Ordway, Driller	Caulkins Venture II	112-115
Ray Domer, Driller	Dunklin Mem. Camp	116
David Webb, Driller	Indiantown	117
D. Spencer, Driller	Burg & Divosta	118
Steve Ordway, Driller	Becker Groves	119
Kenneth Morgan, Driller	Tequesta	120
Steve Ordway, Driller	Becker Groves	121,122
Steve Ordway, Driller	Becker Groves	122
G. Bobo & Assoc	Hydratech	123
Geraghty & Miller	Jupiter	124-127,169
Geraghty & Miller	River Bend Pk	128,129
Geraghty & Miller	PB Country Estates	130-132
USGS	Open File Rpt 79-1543	133-165
USGS	RI 23	167,168
?	PB Pk of Commerce	170
Dames & Moore	Michigan Players Club	172
USGS	Letter to City of Stuart 11/13/86	173,174
Ray Domer, Driller	Evans Prop./Bluefield	175,190
Ray Domer, Driller	Red Top Dairy	176
David Webb, Driller	Kings Bay	177
FL B.O.G.	FBOG Database	178-180
Bechtel	FP&L Coal Gassif.	181-184
Dames & Moore	PalMar WCD	189
SFWMD	Tech Pub 80-5	192-194
Geraghty & Miller	Hobe Sound Plantation	197-209
Enviropact Serv		211
USGS	Open File Rpt 76-713	212-214

FIGURE A-2: Thickness of Layer 1



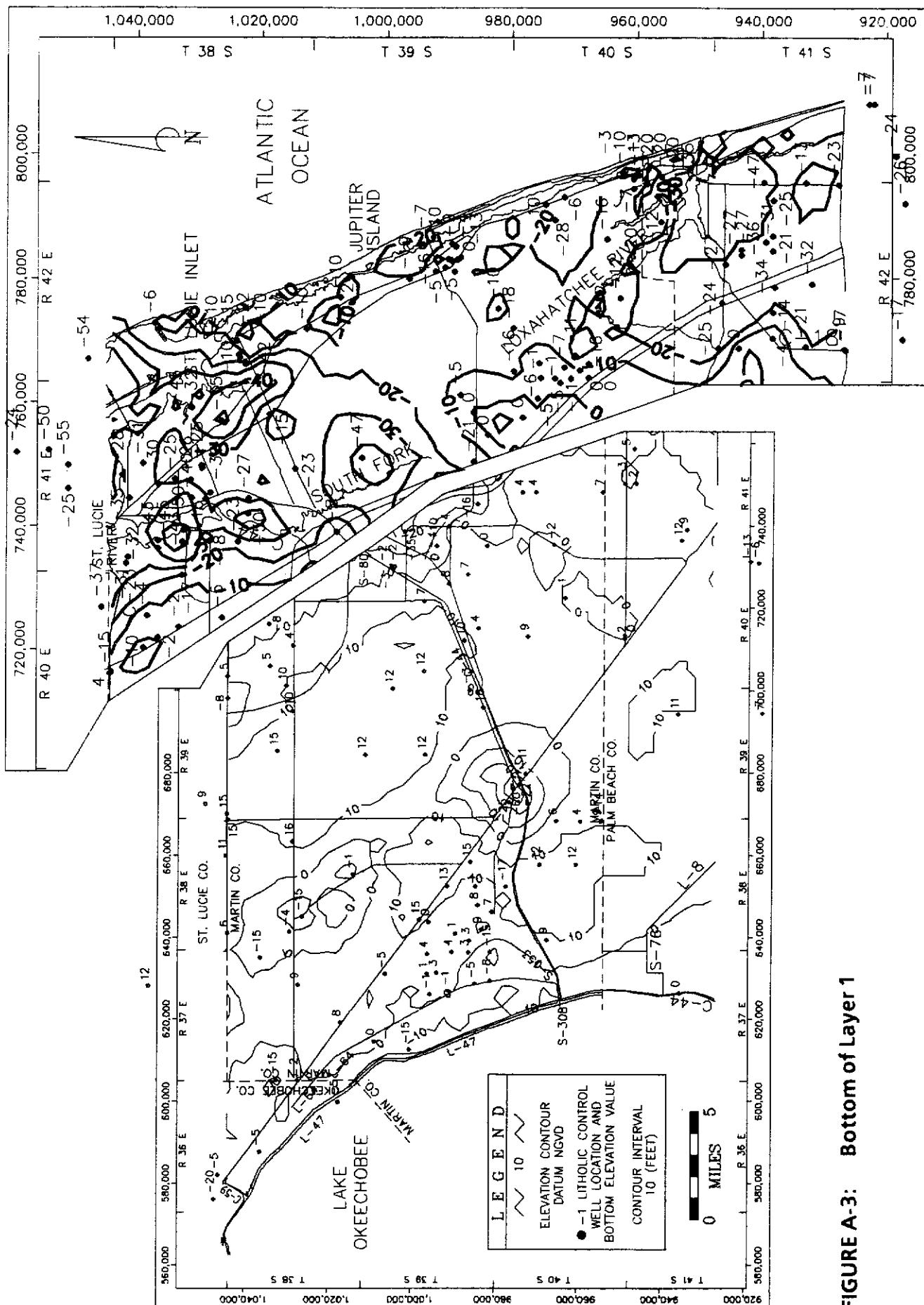


FIGURE A-3: Bottom of Layer 1

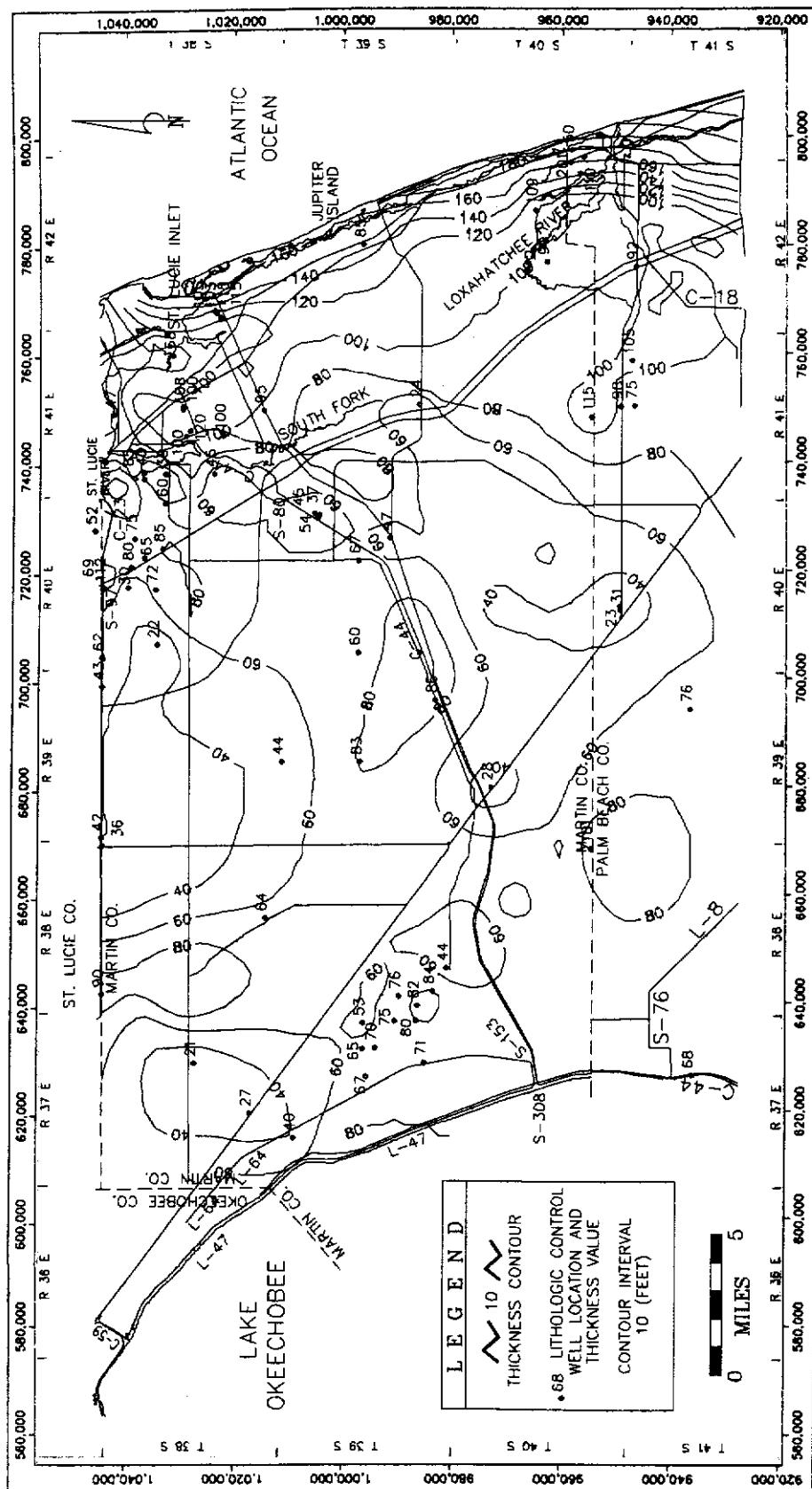


FIGURE A-4: Thickness of Layer 2

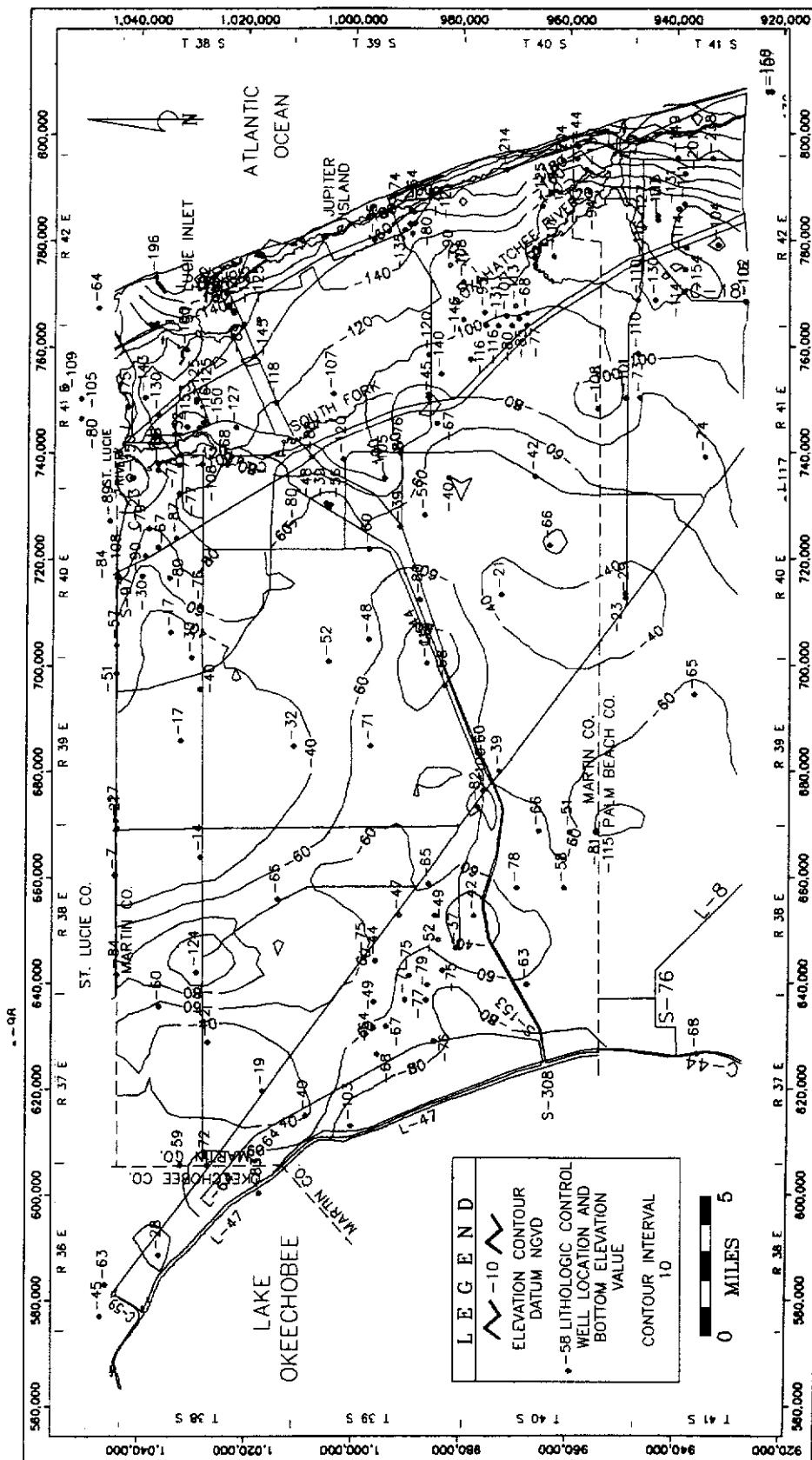


FIGURE A-5: Bottom of Layer 2

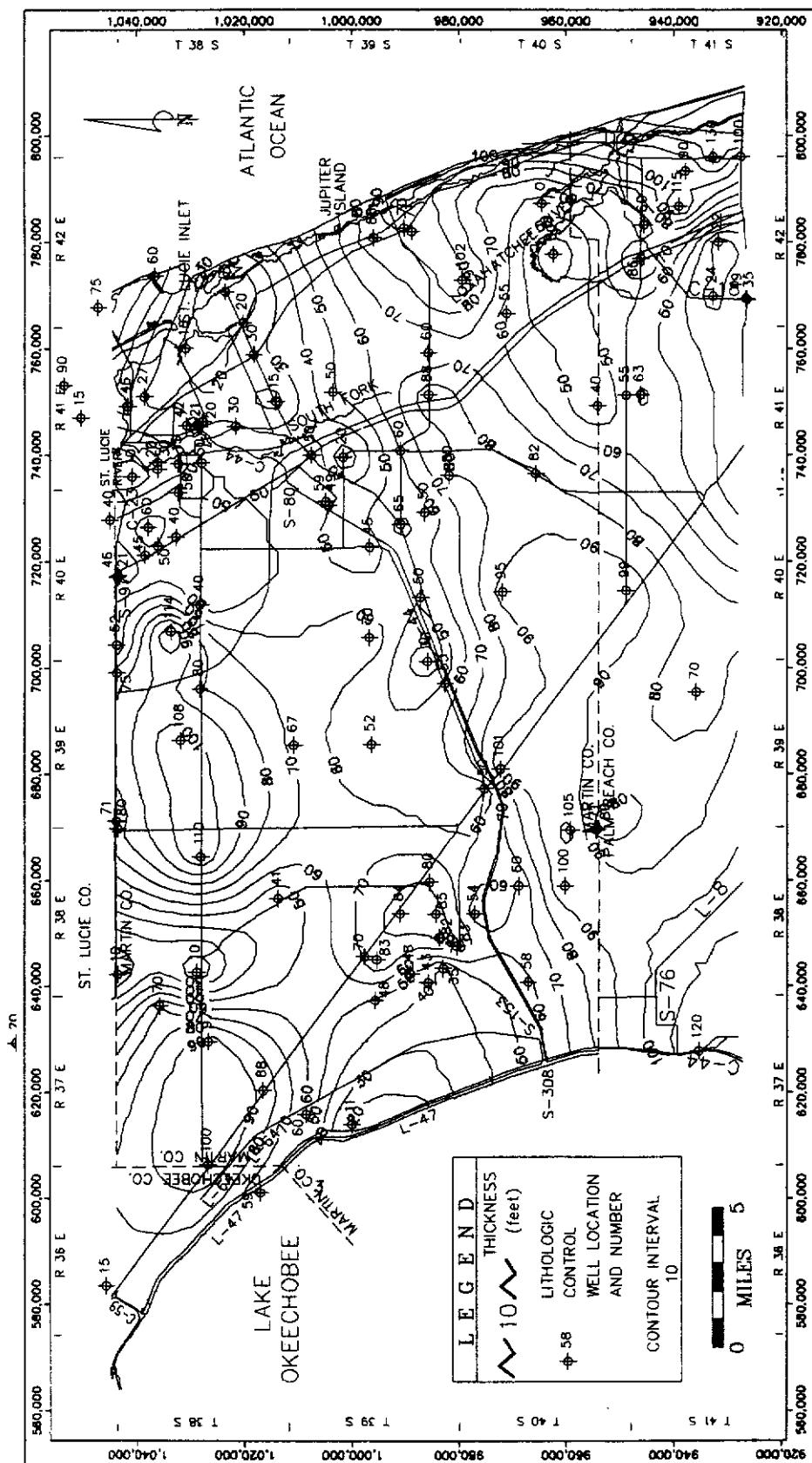


FIGURE A-6: Thickness of Layer 3

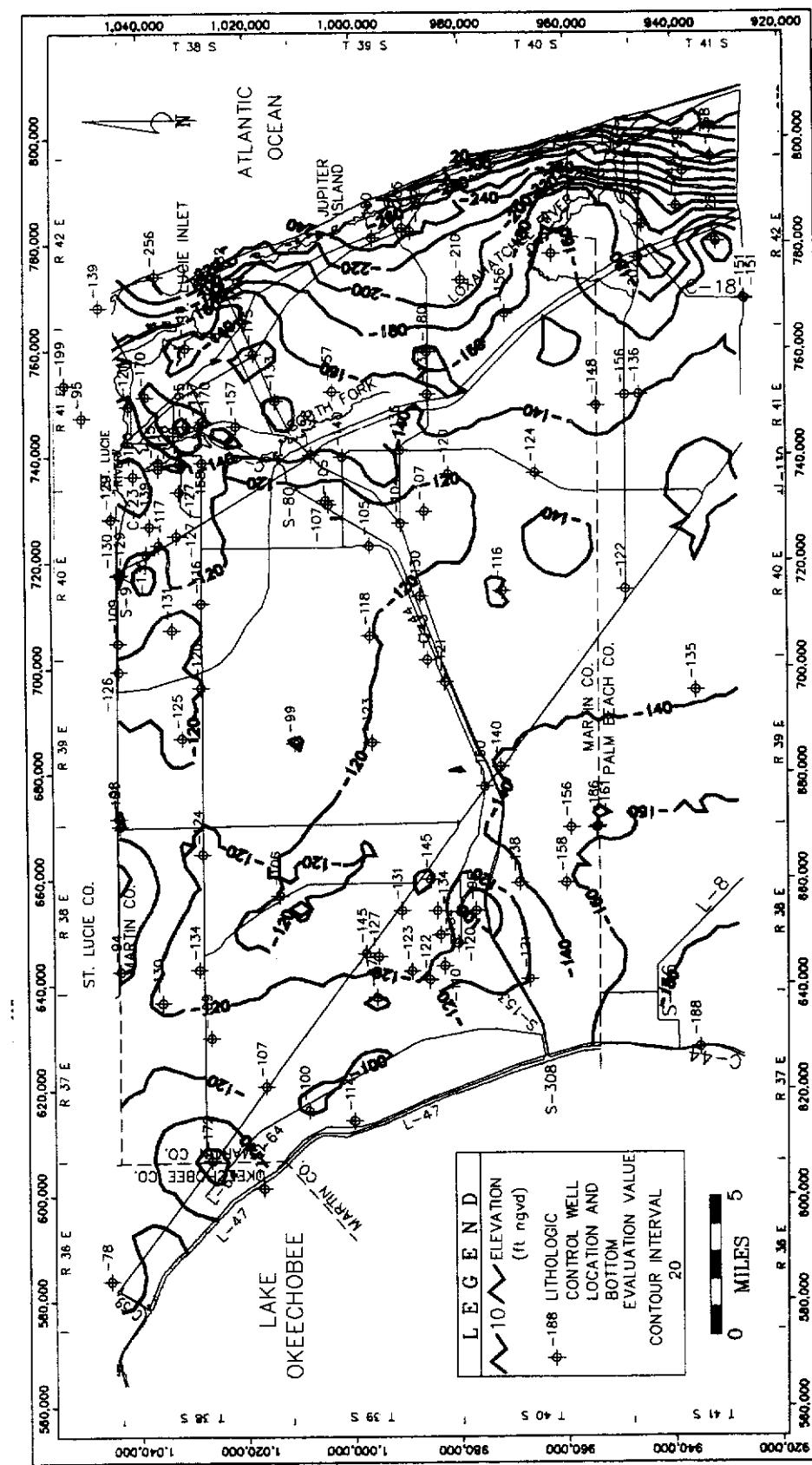


FIGURE A-7: Bottom of Layer 3

APPENDIX B

MAPS OF HYDRAULIC PARAMETERS

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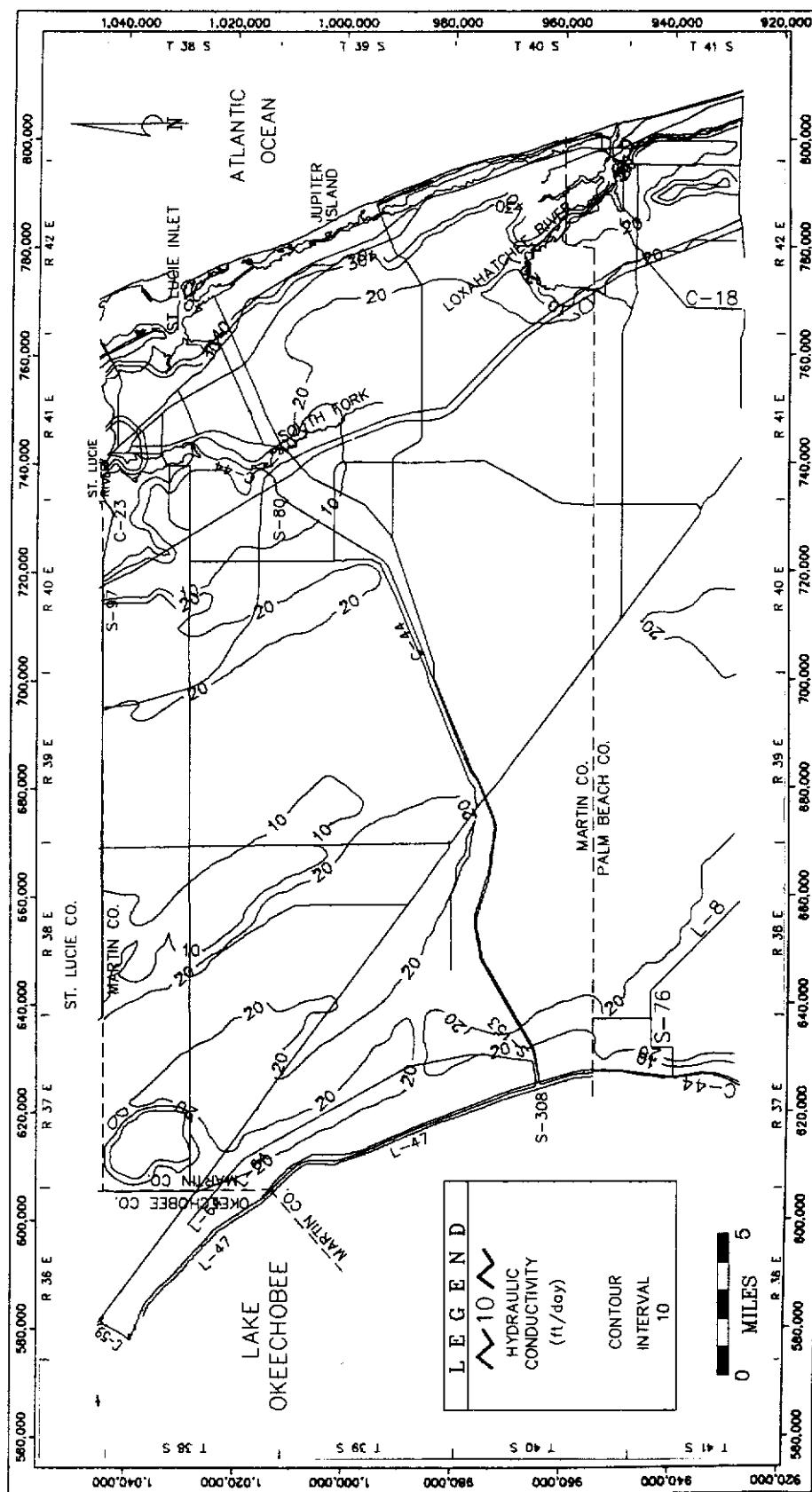


FIGURE B-1: Vertical Soil Conductance (Layer 1 Hydraulic Conductivity)

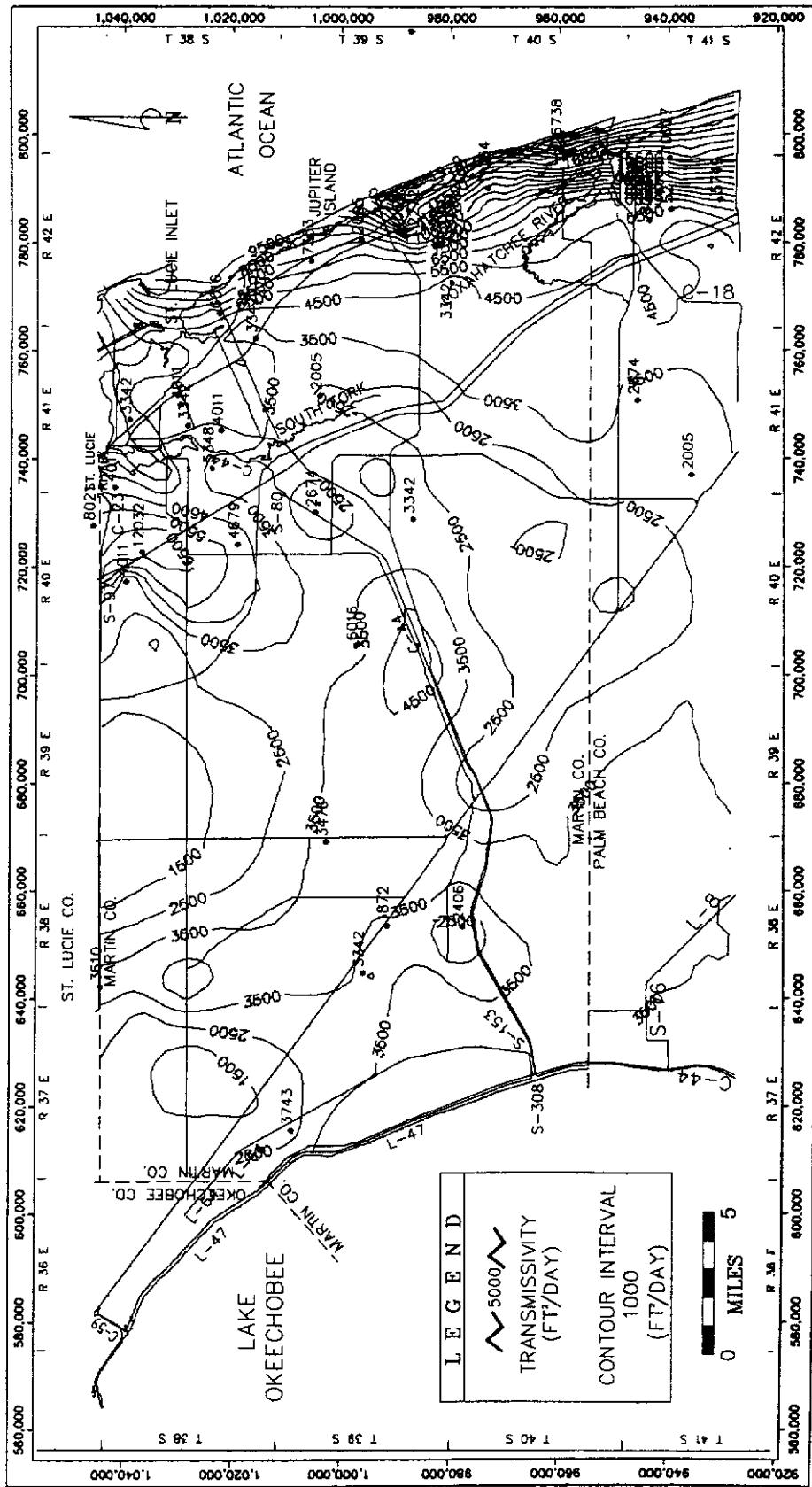


FIGURE B-2: Layer 2 Transmissivity

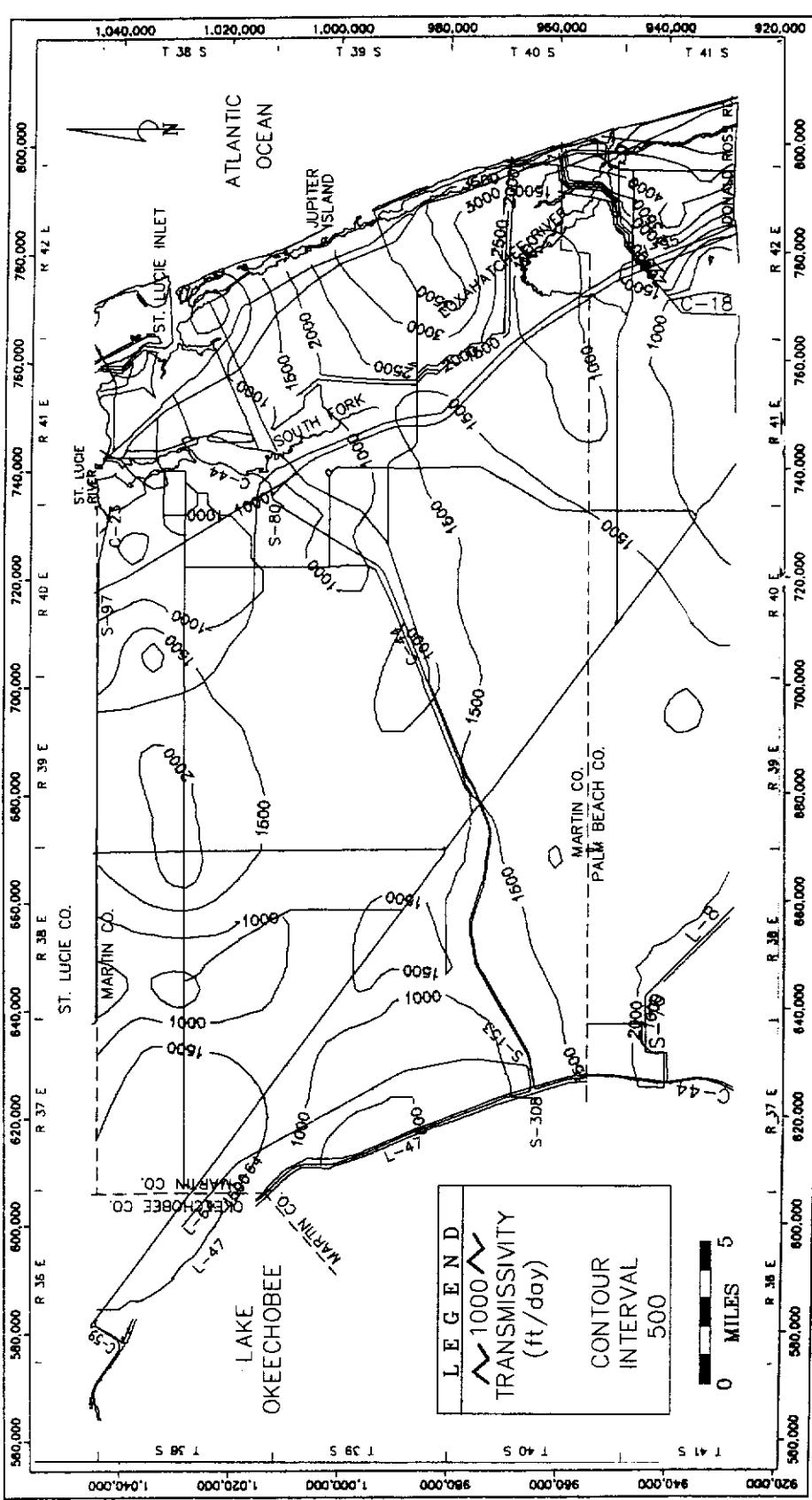


FIGURE B-3: Layer 3 Transmissivity (with multiplier)

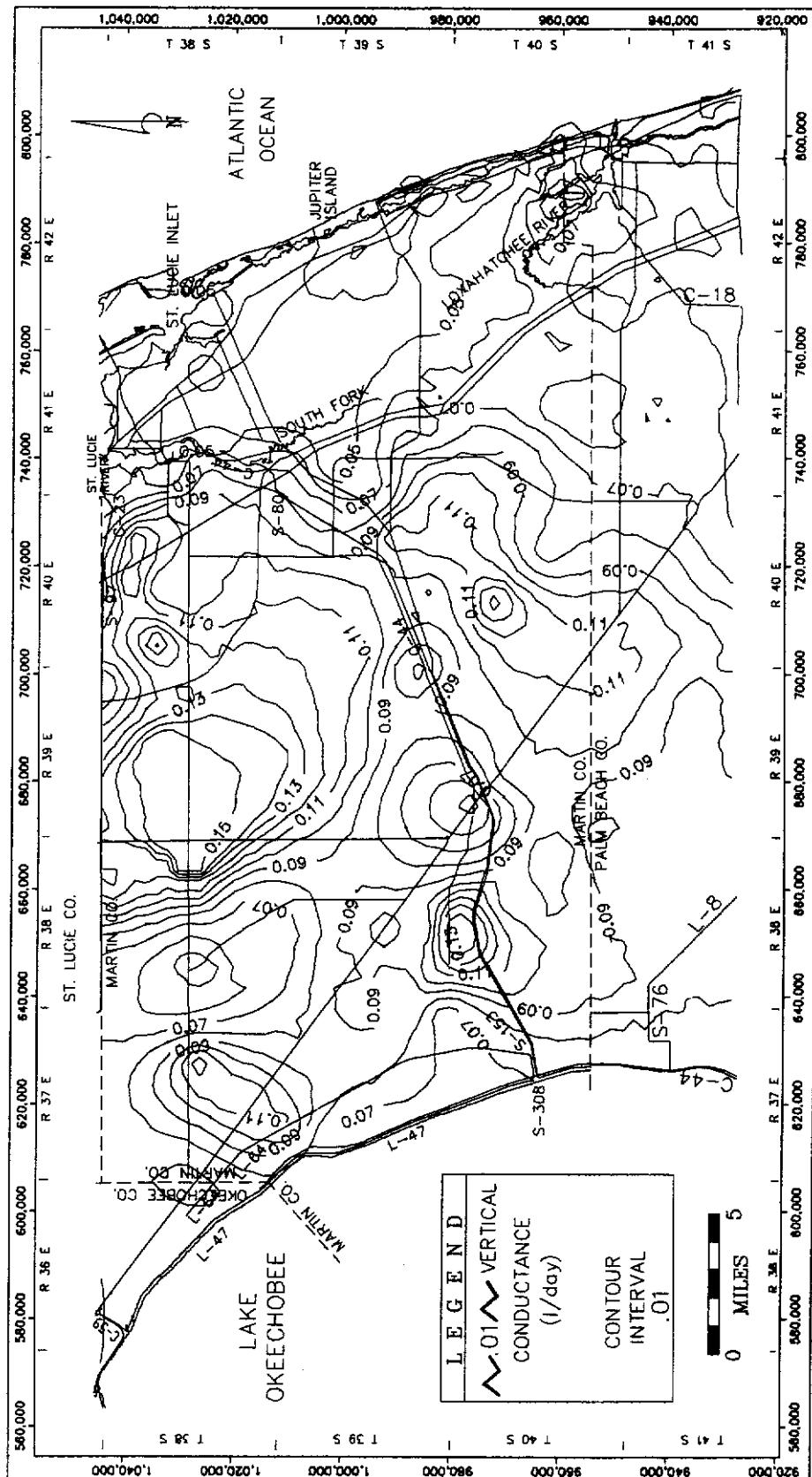


FIGURE B-4: Vertical Conductance (V_{CONT}) Between Layers 1 and 2

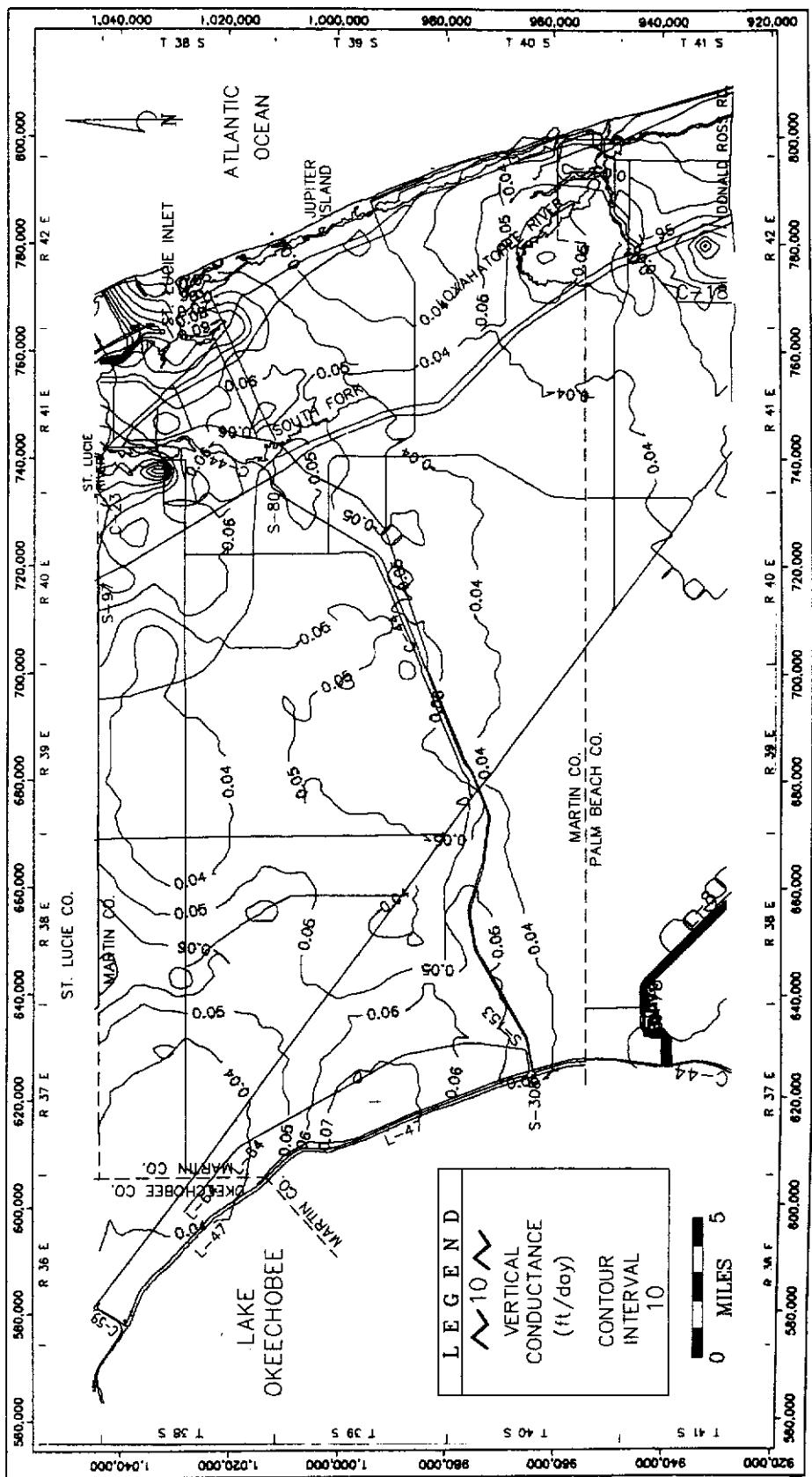


FIGURE B-5: Vertical Conductance (VCONT) Between Layers 2 and 3

APPENDIX C

GENERAL HEAD, RIVER AND DRAIN

INPUT DATA

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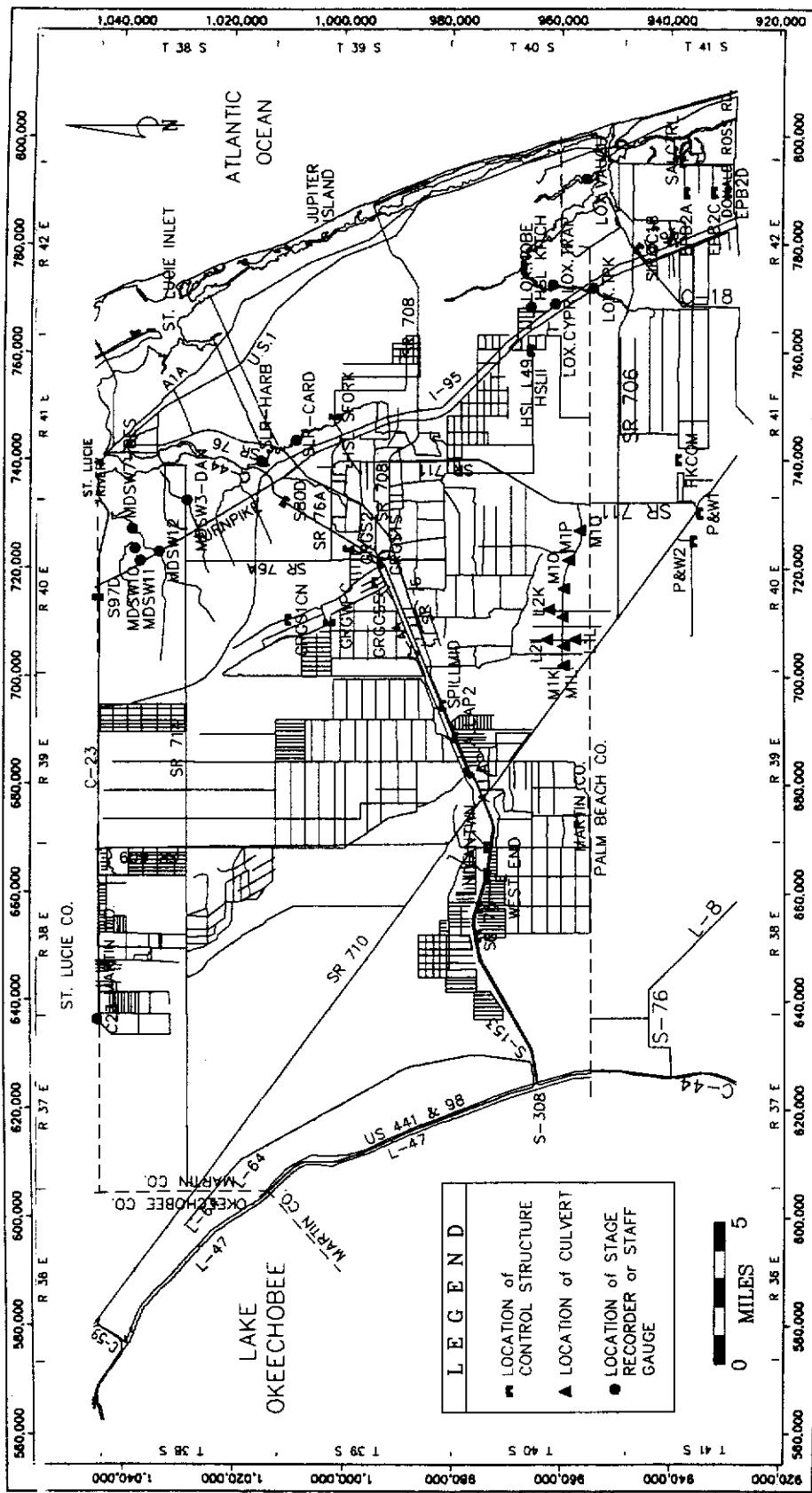


FIGURE C-1: Location of Drain Structures

TABLE C-1: Parameters Used to Describe Canals in Drain Package

DRAIN NAME	WL STATION	BED ELEVATION	RANGE OF WIDTHS OF REACHES IN CELL	Conductance Multiplier	CONSTRUCTION DATA SOURCE	WATER LEVEL DATA SOURCE
Cypress Creek Canal	LOX.CYPR	3 to 12	19 to 30	0.005	COE	SFWMD
SIRWCD West	Culvert invert	9.75 to 15	30	0.005	SIRWCD Drawings	SIRWCD
SIRWCD C-18 to Turnpike	SIR @ TURNP	10	30	0.1	SIRWCD Drawings	SIRWCD
SIRWCD East	SIR @ C18	7 to 10	30	0.1	SIRWCD Drawings	SIRWCD
NPB Heights WCD	canal bottom elev.	6 to 7.9	30	0.1	SFWMD Permit	Permit Map
NPBWCD Unit 9	EPB2A,EPB2B,EPB2C EPB2D,SALCTRL	0 to 3	12 to 20	0.1	Mock, Roos & Assoc.	SFWMD Permit
NPBWCD Unit 16	PkCom	19	9	0.02	SFWMD Permit 50-01400	SFWMD Permit
Pratt & Whitney	P&W1, P&W2		20	0.02	SFWMD Permit	SFWMD Permit
PalMar WCD	M1Q,M1P,M1O,M1N,M1L, M1K,L2K,L1L,L2L	6 to 17.5	6 to 50	0.01	PalMar WCD Phase V Rp.	culvert invents
C-23	S97D	-15 to -6.5	115 to 180	0.001	COE	SFWMD
St. Lucie Estuary	S80D	-13 to -8	145 to 780	0.001	SFWMD Tech Pub 86-4	SFWMD
Bessey Creek	MDWS7-BES, MDSW10	-8 to 5	25 to 75	0.005	Martin Downs SALT map	Martin Downs
Martin Downs Ponds	MDSW11	5	50	0.05	Martin Downs SALT map	Martin Downs
Bessey Creek SW Fork	river bed elevation	7 to 9	50 to 100	0.005	Martin Downs SALT map	Martin Downs
Danforth Creek	bed elev. or MDSW3-DAN	0 to 7	30 to 40	.1 to .01	USGS Topo	Martin Downs
Hidden River	S97D	-7.5 to -6.5	85 to 105	0.01	USGS Topo	SFWMD
Poppolton Creek	S80D	-3 to -2	35	0.01	USGS Topo	SFWMD
Old South Fork St. Lucie Riv.	SLR.HARB, SLR.CARD		20 to 110	.1 to .01	USGS Topo	SFWMD
So. Fork, E. Branch, St. Lucie	S80D	-11 to -4	115 to 215	0.1	USGS Topo	SFWMD
Cypress Creek	LOX.CYPR	-4 to 1	10 to 30	0.05	SFWMD Survey	SFWMD

**TABLE C-1: Parameters Used to Describe Canals in Drain Package
(Continued)**

DRAIN NAME	WL STATION	BED ELEVATION	RANGE OF WIDTHS OF REACHES IN CELL	Conductance Multiplier	CONSTRUCTION DATA SOURCE	WATER LEVEL DATA SOURCE
Hobe Ditch	LOX.HOBE	6 to 7	55 to 60	0.05	USGS Topo	SFWMD
Loxahatchee River (upstream)	LOX.TPK, LOX.TRAP	-3 to 4	20 to 40	.1 to .05	SFWMD Survey	SFWMD
Loxahatchee River	LOX.TRAP	-11 to -4	35 to 250	.1 to .05	SFWMD Survey	SFWMD
North Fork Loxahatchee River	LOX.VAUGH	4 to -1	75 to 1000	0.001	SFWMD Survey	SFWMD
Caulkins Indiantown	ALL.AP2 + 4'	20	20	0.01	USGS Topo, SFWMD Permit	COE
Green Riv. Grove W. Perimeter	GRGWPC	19	12 to 20	0.005	SFWMD Permit 43-00092	SFWMD Permit
Green Riv. Grove Cane Slough	GRGCSS	13	20	0.005	SFWMD Permit 43-00092	SFWMD Permit
Green Riv. Grove S1 North	GRGSIGN	16	20	0.005	SFWMD Permit 43-00092	SFWMD Permit
Green Riv. Grove S1 South	GRGS1CS	16 to 17	20	0.005	SFWMD Permit 43-00092	SFWMD Permit
Green Riv. Grove S2	GRGS2	7.5 to 15.5	20	0.005	SFWMD Permit 43-00092	SFWMD Permit
Troup Indiantown Canal I	+23 Ft. NGVD	23	35	0.01	TI Plan of Reclamation	Plan of Reclamation
Troup Indiantown Canal D	ALL.AP1	16	12 to 50	0.01	TI Plan of Reclamation	Plan of Reclamation
Troup Indiantown Relief Canal	ALL.AP1	16	16	0.01	TI Plan of Reclamation	Plan of Reclamation
Troup Indiantown East Perim.	SPILL.MID	16	16	0.01	TI Plan of Reclamation	COE
Rowland Canal	INDIANTWN	16	30	0.01	USGS Topo	COE
Indiantown WCD	+20 Ft. NGVD	17	25	0.01	USGS Topo	3 feet below land
Talquin Corporation	+19 Ft. NGVD	20	0.01	USGS Topo, SFWMD Permit	3 feet below land	
Via Tropical (43-00117)	SPILL.MID, ALL.AP2	15 to 22	10 to 15	0.01	Discuss w/ Gary Rodrick	COE, Discuss w/R. Baker
Via Tropical (43-00122)	C,D,E (Irrig=D,E+2')	13 to 16	10 to 25	0.01	Discuss w/ Gary Rodrick	COE, 4 ft below land
Maran Groves	canal bed elev. (Irr=19')	15 to 20	17	0.01	USGS Topo, SFWMD Permit	Discuss w/J. Crumb
Indian River Cirrus	bed elev.(Irr= GRGCSS+2')	15 to 20	15	0.01	Discuss w/J. Suzel	COE

**TABLE C-1: Parameters Used to Describe Canals in Drain Package
(Continued)**

DRAIN NAME	WL STATION	BED ELEVATION	RANGE OF WIDTHS OR REACHES IN CELL	Conductance Multiplier	CONSTRUCTION DATA SOURCE	WATER LEVEL DATA SOURCE
Indian Sun Robinson Grove	+16.22' NGVD (lr= +18')	16	20	0.01	Grove drawings(LBF&H)	Discuss w/grove operator
HSLCD L-42	HSL Kitch + 2'	7	15	0.01	Grove Drawings(MockRoos)	Discuss w/grove operator
HSLCD L-41, L-39, L-38	HSL Kitch	7	12	0.01		3 feet below land
HSLCD L-35	HSL Kitch	7	45	0.01		3 feet below land
HSLCD L-45, L-46	HSL Kitch	2	53 to 58	0.01		3 feet below land
HSLCD Gulfstream Outfall	LOX.HOBEE	0	58	0.01	SFWMD	
HSLCD Hobe Relief Canal	LOX.CYPR	5	30	0.01	SFWMD	
HSLCD Grove II Outfall	HSL II	3	40	0.01		3 feet below land
HSLCD L-26,L-27,L-28,L-30,L-33	HSL II	10	12	0.01		3 feet below land
HSLCD L-18 & L-29 (Irrig)	HSL II + 2'	10	12	0.01		1 foot below land
HSLCD L-49, L48	HSL L49	10	18 to 26	0.01		3 feet below land
HSLCD L-52	HSL L49	10	13	0.01		3 feet below land
HSLCD L-51, L-54, L-55, L-56	HSL L49	10	12	0.01		3 feet below land
HSL Grove I	HSL SFORK	8	12	0.01		3 feet below land
HSL Grove I (Irrig.)	HSL SFORK + 2'	8	12	0.01		1 foot below land
Allapatah Ranch (North Area)	C23		12	0.01	Discuss w/Allapatah SFWMD	
Allapatah Ranch (Slough Area)	+28' NGVD		12	0.01	Discuss w/Allapatah	1 foot below land
Carlton Groves	C23		12	0.01	USGS Topo, SFWMD Permit	SFWMD
Evans Groves	+20' NGVD		12	0.01	USGS Topo, SFWMD Permit	
Becker Groves	+23' NGVD		12	0.01	Discuss w/operator	3' to 5' below land
Agri-Lan	+22' NGVD		12	0.01	USGS Topo, SFWMD Permit	3' below land
Armstrong Grove	+15' NGVD	15	25 to 30	0.01	USGS Topo, SFWMD Permit	3' below land
Armstrong Pasture	+15' NGVD	15	20	0.01	USGS Topo, SFWMD Permit	USGS Topo

TABLE C-1: Parameters Used to Describe Canals in Drain Package
(Continued)

DRAIN NAME	WL STATION	BED ELEVATION	RANGE OF WIDTHS OF REACHES IN CELL	Conductance Multiplier	CONSTRUCTION DATA SOURCE	WATER LEVEL DATA SOURCE
Tidetke Grove	bed elevation	13 to 16	17	0.01	USGS Topo, SFWMD Permit	USGS Topo
Bridge Meadow Farms	bed elevation	16 to 21	15	0.01	USGS Topo, SFWMD Permit	USGS Topo
Monreve Ranch	bed elevation	16 to 19	15	0.01	USGS Topo, SFWMD Permit	USGS Topo
Box Ranch	bed elevation	12 to 19	15	0.01	USGS Topo, SFWMD Permit	USGS Topo
Tropical Farms Area	bed elevation	9 to 14	10	0.1	USGS Topo	USGS Topo
Tributaries to S Fork St. Lucie	bed elevation	6 to 13	10	0.1	USGS Topo	USGS Topo
Roeback Creek	bed elevation	2 to 17	10	0.1	USGS Topo	USGS Topo

TABLE C-2: Structure Elevation Data Used in Drain Package

STRUCTURE (WEIR) NAME	WEIR ELEV (NGVD)
LOX.CYPR	1.54
SIR@TURNP	13 wet 14 dry
SIR@C18	10.5
EPB2A	8
EPB2B	9
EPB2C	11
EPB2D	11
SALCTRL	6.01
PKCOM	21
P&W1	20
P&W2	23.5
M1Q	23.5
M1P	22.5
M1O	22.5
M1N	24.5
M1L	25
M1K	26.4
L2K	23.5
L1L	25
L2I	25
GRGWPC	18
GRGCSS	12.8
GRGS1CN	19.4
GRGS1S	19
GRGS2	13.9
ALLAP1	15.96
SPILLMID	16
ALLAP2	16

STRUCTURE (WEIR) NAME	WEIR ELEV (NGVD)
INDIANTWN	16
WEST END	16
C(C-44)	15.8
D(C-44)	15.8
E(C-44)	15.8
HSL KITCH CRK	13
LOX.HOBE	2.17
HSL II	15
HSL L49	15
HSL SFORK	11
S97D	0.27 (7.79)
S80D	0.27 (0.32)
MDSW7-BES	0.27 (2.42)
MDSW10	0.27 (4.19)
MDSW11	0.27 (12.38)
MDSW12	0.27 (6.66)
MDSW3-DAN	0.27 (1)
SLR-HARB	0.27
SLR-CARD	0.27
LOX.TPK	0.44 (2.75)
LOX.TRAP	0.44 (0.66)
LOX.VAUGH	0.38
C23	21.48

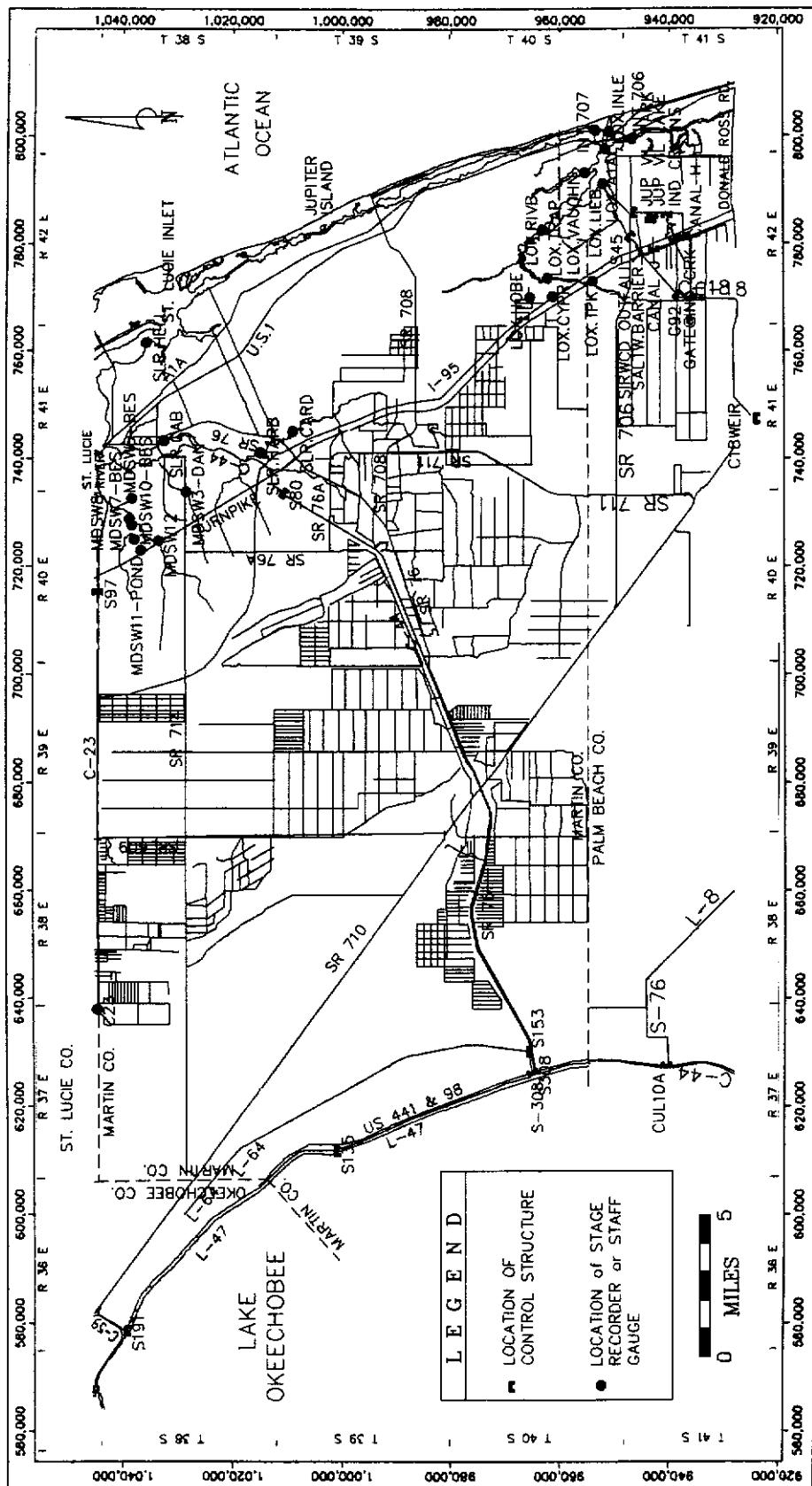


TABLE C-3: Parameters Used to Describe Canals/Rivers in River Package

RIVER NAME	WL STATION	BED ELEVATION	RANGE OF WIDTHS OF REACHES IN A CELL	Conductance Multiplier	CONSTRUCTION DATA SOURCE
C-23(Tidal)	SLR.HELL	-15	180	0.01	COE As Built 1964
C-23	C-23, S97U	-3 to 4	85 to 110	0.01	COE As Built 1964
St. Lucie River	SLR.CAB, SLR.HELL	-15 to -2	960 to 2000	0.0001	SFWMD Tech Pub 86-4
Indian River	SLR.HELL	-13 to -3	800 to 2000	0.0001	SFWMD Tech Pub 86-4
St. Lucie Inlet	SLR.HELL	-10	1740 to 1840	0.0001	SFWMD Tech Pub 86-4
C-44	S308D, S80U	-10 to -8	175 to 200	0.01	COE Deepening 1949
L-47 (Section 1)	S135U	-16 to -10	200 to 240	0.01	COE As Built 1965
L-47	S135U	-8	160	0.01	COE As Built 1965
C-59	S135U	-10	180	0.01	COE As Built 1965
L-63, L-64	S191U	1.2 to 20	30 to 70	0.01	COE As Built 1973
L-65	S153U	2 to 14	30 to 55	0.01	COE As Built 1983
Great Pocket	SLR.HELL	-4	500 to 1500	0.001	NOAA Charts
Intracoastal(Martin Co.)	SLR.HELL, INT.707	-10 to -2	150 to 1700	0.001	NOAA Charts
Jupiter Inlet	LOX.INLE	-10 to -6	400	0.001	NOAA, USGS Topo
Intracoastal(P.B.Co.)	LOXA1A, INT.706	-9 to -2	200 to 300	0.001	NOAA Charts
Canals off Gomez Rd	SLR.HELL	-5	50 to 150	0.001	NOAA, USGS Topo
Jonathan's Landing	INT.706	-5	100 to 400	0.001	USGS Topo, SFWMD Permit
Frenchmans Creek	INT.706	-5	150	0.001	USGS Topo, SFWMD Permit
Manatee Pocket	SLR.HELL	-8 to -6	230 to 1375	0.001	SFWMD Tech Pub 86-4
Willoughby Creek	SLR.HELL	-4 to -3	75 to 250	0.001	UGSG Topo
Loxahatchee River (Tidal)	LOX.RIVB, LOXLINEB	-9 to -3	200 to 2000	0.001	SFWMD Survey

**TABLE C-3: Parameters Used to Describe Canals/Rivers in River Package
(Continued)**

RIVER NAME	WL STATION	BED ELEVATION	RANGE OF WIDTHS OF REACHES IN A CELL	Conductance Multiplier	CONSTRUCTION DATA SOURCE
C-18	LOXLIEB	-11 to -3.5	150 to 800	0.0001	COE Drawings
C18 Section 2	S46U, G92D, G92U	-4 to -2	140 to 150	0.01	COE As Built 1956
C18 West Leg	C18Weir(D)	2 to 6	70	0.01	COE As Built 1956
L-8	SSAE, CUL10AD	-10 to 7	50 to 65	0.01	COE
L8N Tieback	CUL10AD	0 to 15	40	0.01	COE
NPB Heights Outfall Canal	SALT.W.B	-2 to 5	48	0.001	SFWMD Permit
SIRWCD (Adj. C18)	SIRWCD.OU	8	30	0.001	
SIRWCD (Adj. Turnpike)	CANAL J, CANAL H	8	30	0.001	Jupiter Surface Water Recharge System Drawing 2/90
Indian Creek	GATE @ IND	4 to 5.9	40 to 500	0.001	
Jupiter Village Lake	JUPVILL.LK	4.5	250	0.001	
Jupiter Village Park	JUPVILLPK	4.5	50	0.01	

TABLE C-4: Stage Data Used in River Package

STATION	JAN 1989	FEB 1989	MAR 1989	APR 1989	MAY 1989	JUN 1989	JUL 1989	AUG 1989	SEP 1989	OCT 1989	NOV 1989	DEC 1989	1989 AVE.	DATA SOURCE
SLR.HELL	0.44	0.29	0.47	0.12	0.16	-0.12	0.1	0.42	0.48	1.86	0.62	0.46	0.44	SFWMD
S97D	7.56	7.51	7.58	7.51	7.47	7.61	8.03	7.68	8.43	8.06	8.04	7.76		
S97U	20.41	20.16	21.98	21.17	20.12	19.07	21.76	21.94	21	22.18	21.62	21.79	21.10	
C23	20.36	19.58	22.31	21.52	20.49	19.4	22.11	22.28	21.53	22.49	21.98	22.14	21.35	
S308D	14.17	13.84	13.57	13	12.56	11.57	11.34	11.39	11.8	12.66	12.62	12.01	12.54	
S80U	14.19	13.84	13.6	12.97	12.48	11.53	11.39	11.34	11.86	12.7	12.64	12.06	12.55	
S80D	0.35	0.21	0.4	0.18	0.2	-0.16	0.05	0.39	0.78	0.81	0.47	0.29	0.33	
S133U	13.47	13.65	13.52	13.01	12.55	11.64	11.34	11.37	11.8	12.65	12.57	12.3	12.49	
S191U	19.39	19.36	19.24	19.38	19.26	18.72	19.07	19.35	19.44	19.38	19.37	19.09	19.25	
S153U	19.13	19.16	19.13	19.14	19.12	19.17	19.14	19.14	19.14	19.15	19.14	19.12	19.14	
LOX.INLE	0.26	0.23	0.38	0.2	0.21	-0.02	0.14	0.38	0.76	0.83	0.49	0.38	0.35	
LOX.AIA	0.49	0.39	0.55	0.27	0.31			0.55	0.87	1.81	0.65	0.49	0.57	
LOX.CYPR	1.26	0.72	1.61	1.13	0.91	0.92	1.62	2.41	1.91	3.18	1.76		1.59	
LOX.HOBE	1.97	1.67	2.08	1.97	1.79	1.99	2.39	2.55	2.26	2.59	2	2.03	2.11	
LOX.TPK	2.69	1.67	2.52	2.74	2.14	1.7	3.29	4.44	4.32		3.23	2.93	2.92	
LOX.TRAP	0.63	0.5	0.72	0.48	0.46	0.18	0.42	0.84	1.19	1.33	0.88	0.7	0.69	
LOX.RIVB	0.43	0.42	0.6	0.38	0.35	0.16	0.24	0.39	0.74	0.83	0.5	0.34	0.45	
LOX.LIEB	0.4	0.31	0.45	0.24	0.24	0.05	0.25	0.49	0.86	1.75	0.63	0.47	0.51	
S46U	12.2	11.83	12.73	12.43	11.95	12.24	12.91	14.74	14.72	14.65	14.41	14.59	13.28	
G92D	10.64	10.49	10.8	10.86	10.63	10.37	11.01	11.29	11.53	11.81	11.06	10.9	10.95	
G92U	12.17	11.86	12.75	12.52	12.09	12.22	12.8	14.68	14.64	14.6	14.39	14.58	13.28	
SALTW.BARRIER	0.58	0.33	0	0.61	0.2	0.15	-0.05	0.22	0.92	0.55	-0.2	-0.35	0.17	
SLR.CAB	0.67	0.53	0.75	0.37	0.44	0.15	0.31	0.66	0.79	2.15	0.84	0.72	0.70	

TABLE C-4: Stage Data Used in River Package (Continued)

STATION	JAN 1989	FEB 1989	MAR 1989	APR 1989	MAY 1989	JUN 1989	JUL 1989	AUG 1989	SEP 1989	OCT 1989	NOV 1989	DEC 1989	1989 AVE	DATA SOURCE
INT.707	0.33	0.61	0.65	0.67	0.14	-0.1	0.1	0.43	1	0.5	0.72	0.7	0.48	USGS
INT.706	-0.83	-0.89	-0.66	-0.93	-1.21	-0.8	-1	-0.81	-0.42	-0.35	-0.66	-0.81	-0.76	
SLR.HARB	0.32	0.18	0.4	0.02	0.09	-0.2	-0.04	0.31	0.44	1.8	0.49	0.37	0.35	SFWMD
SLR.CARD	0.47	0.33	0.55	0.17	0.24	-0.05	0.11	0.46	0.59	1.95	0.64	0.52	0.50	
LOX.VAUGH	0.29	0.26	0.41	0.23	0.24	0.01	0.17	0.41	0.79	0.86	0.52	0.41	0.38	
C18WEIR(D)	12.55	11.95	13.02	12.76	12.3	12.28	14.04	15.45	15.2	15.02	14.61	14.26	13.62	
SSAE	12.79	11.61	13.06	12.53	11.79	10.6	11.51	12.19	12.82	13.28	13.57	11.95	12.31	
CULL10AD	14.23	13.82	13.54	13.04	12.6	11.58	11.31	11.37	11.87	12.82	12.51	11.89	12.55	
SIRWCD OUT	10.08	9.82	10.08	10.22	9.93	9.98	10.2	10.56	10.54	10.51	10.42	9.19	10.13	Jupiter
CANAL J	9.86	9.36	10.1	10.27	9.11	9.48	10.61	10.5	10.53	10.33	10.39	9.07	9.97	
CANAL H	DRY	9.96	DRY	DRY	15.96	DRY	8.83							
GATE@IND CRK	6.76	6.76	6.91	7.02	6.51	6.86	9.36	7.01	7.4	6.86	7.28	7.61	7.20	
IND CREEK NS	DRY	7.5	DRY	4.29										
JUP VILL LAKE	0.85	-0.07	0.7	0.3	DRY	0.15								
JUP VILL PARK	DRY	5.04	DRY	4.55										
MDSW3-DAN	1		1					1			1		1.00	Martin Downs
MDSW6-BES	4.2		4.2					4.22			4.16		4.20	
MDSW7-BES	2.68		1.5					2.8			2.71		2.36	
MDSW8	0.35		0.20					0.20			0.0			
MDSW10-BES	4.14		4.05					4.24			4.35		4.20	
MDSW11-POND	12.4		12.52					12.3			12.31		12.38	
MDSW12	6.48		6.68					6.54			6.96		6.64	

TABLE C-5: Data Used in General Head Cells

WATER BODY/ STRUCTURE	JAN89	FEB89	MAR89	APR89	MAY89	JUN89	JUL89	AUG89	SEP89	OCT89	NOV89	DEC89	AVG89
ST LUCIE RIVER (S80D)	0.35	0.21	0.4	0.18	0.2	-0.16	0.05	0.39	0.78	0.81	0.47	0.29	0.33
INDIAN RIV./INLET (SLR,HELL)	0.44	0.29	0.47	0.12	0.16	-0.12	0.1	0.42	0.48	1.86	0.62	0.46	0.44
ATLANTIC OCEAN (Avg. of SLR,HELL & LOX,INLE)	0.35	0.26	0.43	0.16	0.19	-0.07	0.12	0.4	0.62	1.35	0.56	0.42	0.40
LAKE OKEE (OK2)	14.27	13.84	13.56	13.02	12.55	11.57	11.33	11.31	11.77	12.65	12.62	12.38	12.57
FPL RESERVOIR	30.73	30.43	30.36	30.73	29.97	30.81	30.38	30.72	30.56	30.45	30.53	30.75	30.54
S9TU	20.41	20.16	21.98	21.17	20.12	19.07	21.76	21.94	21	22.18	21.62	21.79	21.10
C23	20.36	19.58	22.31	21.52	20.49	19.4	22.11	22.28	21.53	22.49	21.98	22.14	21.35
S9TD	7.56	7.51	7.58	7.58	7.51	7.47	7.61	8.03	7.68	8.43	8.06	8.04	7.79

Data Source:

All data is collected by the South Florida Water Management District except for the Florida Power and Light (FP&L) Reservoir value which was supplied by FP&L.
Values for the north and south boundaries of the model were generated by the kriging interpolation technique.

APPENDIX D

**RECHARGE METHODS,
RAINFALL STATION MAP AND TABLE,
RECHARGE AND ET COEFFICIENTS**

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RECHARGE

The average recharge depth in a model cell resulting from precipitation, R_p , can be computed using the mass balance equation as:

$$R_p = P_n - Q_d - ET_u - ET_s \quad (1)$$

where

P_n is the average net precipitation depth over the cell not lost to interception or depressional storage,

Q_d is the average depth of water lost to surface drainage (not otherwise simulated using a MODFLOW package), and

ET_u is the average evapotranspiration depth from the unsaturated zone (not calculated by the evapotranspiration package in MODFLOW).

ET_s is the average evapotranspiration depth from the saturated zone (calculated by the evapotranspiration package in MODFLOW).

The evapotranspiration from the unsaturated zone, ET_u , was not considered in this model. In areas where there is a significant unsaturated zone above the water table, however, the recharge calculations may become inaccurate without considering ET_u . This limitation will be resolved in the complete recharge package (currently under development).

Net Precipitation: The average monthly net precipitation depth, P_n , for a cell can be approximated from the total monthly precipitation depth over the cell, P_t , as:

$$P_n = \text{MAX}\{K_i P_t - (\sum_{n=1}^N K_d(n)), 0\} \quad (2)$$

where

K_i is the interception coefficient,

$K_d(n)$ is the daily depression storage loss due to evaporation, and

n is the number of days in the month.

Interception is that portion of gross precipitation which wets and adheres to above ground objects until it returns to the atmosphere through evaporation (Bower, et al., 1990). The quantity of water intercepted depends upon the storm character, the season of the year, and the species, age, and density of the prevailing plants and trees. The total interception by an individual plant is directly related to the amount of foliage. For non-urban land uses, extreme values of K_i can be defined as (Viessman, et al., 1977):

$$K_i = \begin{cases} 1.00 & \text{for clear bare ground surface (0% interception)} \\ & \\ 0.75 & \text{for dense closed forest (25% interception).} \end{cases}$$

Values for K_i in urban areas ranged from 1.00 to 0.50, depending upon the land use type. The value of K_i assigned to a model cell represented the weighted average of the K_i values for all land use types within the cell. Table D-3 lists land use types and corresponding values for K_i .

Precipitation that reaches the ground surface may infiltrate, flow over the surface, or become trapped in numerous small depressions. The depression-storage loss for impervious drainage areas varies from 0.05", on a slope of 2.5%, up to 0.11", on a slope of 1% (Bower, et al., 1990). The upper limit of 0.11" was assumed

for each precipitation event. The model depression storage loss, K_d , was calculated as:

$$K_d = K_d^{\max} \{ \text{MAX}\{[1 - \text{SQR}(K/K_m)], 0\} \} \quad (3)$$

where

K_d^{\max} is the sum of maximum depression storage losses for the stress period computed on a daily basis (an upper limit of 0.11 was assumed for each day),

K is the hydraulic conductivity of the soil layer, and

K_m is a calibration factor. It is defined as the value of hydraulic conductivity at which infiltration is assumed to be nearly instantaneously related to the potential evaporation rate.

A value of $(K/K_m) = 0$, signifying an impervious drainage area, implies a value of $K_d = 0.11"$ per single precipitation event, and a value of $(K/K_m) = 1$, a highly pervious area, implies a $K_d = 0$. Rainfall of less than the critical daily precipitation depth K_d evaporates and creates neither infiltration nor runoff drainage.

Only one precipitation event per rainy day of at least 0.11" was assumed. Interception - storage capacity is usually reached early in a storm event. This implies that a larger fraction of rainfall is intercepted in depressions during numerous small storms than during infrequent severe storms (Bower, et al., 1990).

The value of soil hydraulic conductivity, K , in a model cell was estimated by examination of the tables of saturated vertical permeability for applicable soil types found in Soil Conservation Service soil survey books (McCollum, et al., 1981 and McCollum, et al., 1978). Soil permeability values ranged from 2 feet/day to 47 feet/day throughout the modeled area. The instantaneous hydraulic conductivity, K_m , was set at 47 ft/day.

Surface Drainage: The surface drainage depth is defined as the difference between the net precipitation depth, P_n , and the net infiltration (Bower, et al., 1990). Then net average depth of water lost to surface drainage, Q_d , can be estimated by:

$$Q_d = (K_s)(K_a)(P_n) \quad (4)$$

where

K_s is a coefficient relating the potential for runoff to surface drainage, and

K_a is a coefficient relating the potential for aquifer recharge from surface drainage.

K_s varies between 0 and 1, depending on the potential of the land use type to have surface drainage into a canal or into a surface water body. Factor K_a takes into account the effect of drainage systems which may recharge the unsaturated zone of the aquifer. The value of K_a is a function of the average hydraulic conductivity and the average slope of the land surface. It has a value of 1 if there is no drainage into the unsaturated zone, and has a value of 0 when rainfall completely recharges the unsaturated zone. Model values for K_a varied between .1 and .3. Table D-3 lists land use codes and the K_a value assigned for each code. The value for K_a was uniformly set to 0.1 and was defined as:

$$K_a = K_a^{\max}(1-K/K_{\max}) \quad (5)$$

where

K_a^{\max} is the maximum value that K_a may take (less than or equal to 1), and

K_{\max} is the maximum soil hydraulic conductivity in the study area.

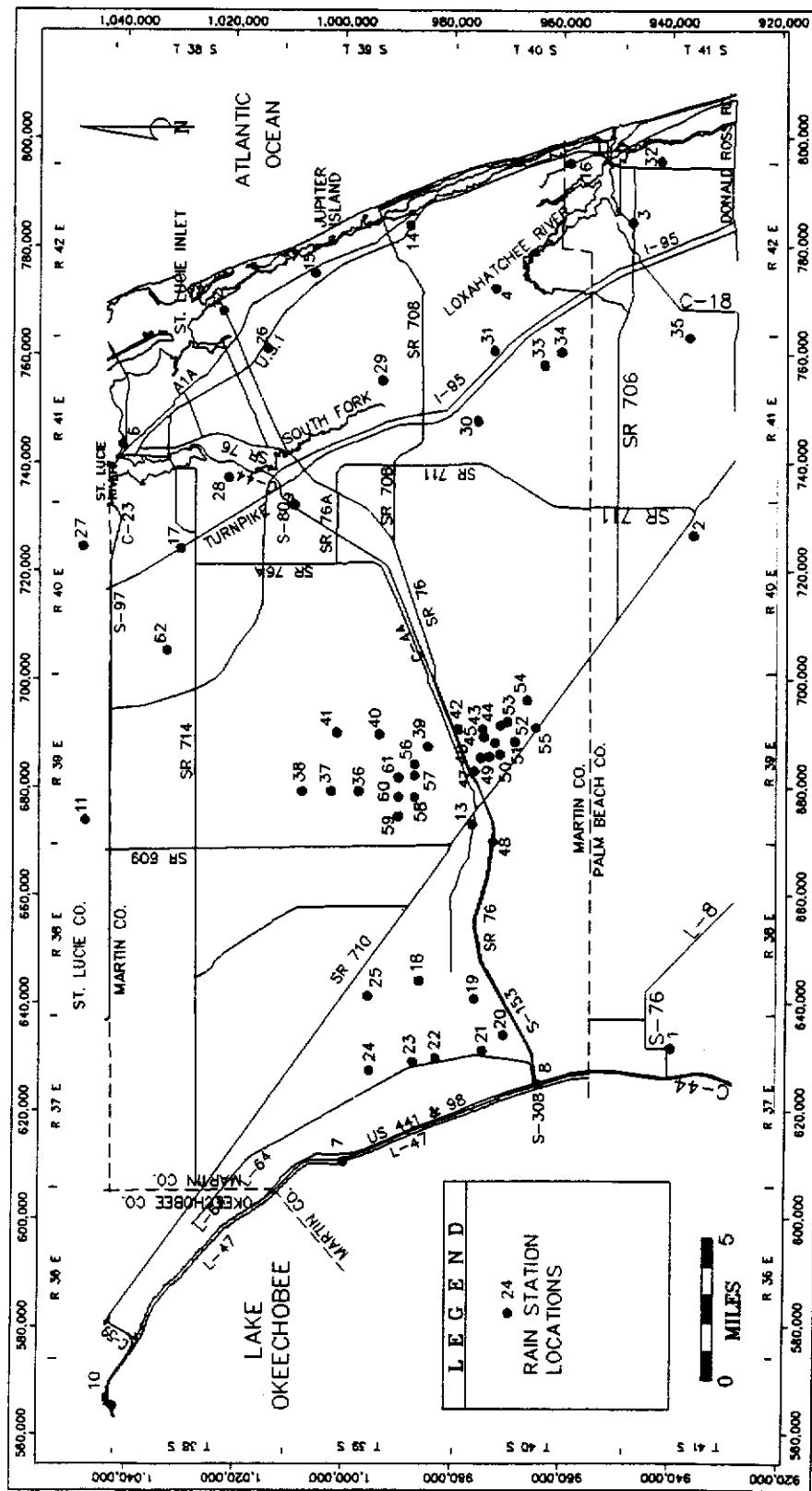


FIGURE D-1: Locations of Rainfall Stations

TABLE D-1: Rainfall Station Descriptions

Map No.	State Plane Coordinates		Rainfall Station	Source
	East	North		
1	631328	939000	North Unit	SFWMD
2	726776	934919	Pratt & Whitney	SFWMD
3	785001	946690	Simms Creek	SFWMD
4	772612	972256	Kitchings Creek	SFWMD
5	739724	1058288	No Mt Co Water Plant	SFWMD
6	743790	1042559	Stuart 1N	USWB
7	610177	1000579	S-135	SFWMD
8	624749	963968	S-308	USWB
9	732597	1010079	S-80	USWB
10	564645	1044001	S-133	SFWMD
11	673871	1049370	BlueGoose	SFWMD
12	768500	1023500	Miles Grant	Miles Grant Utility
13	673050	976400	Indiantown	Indiantown Utility
14	784500	988400	Hobe Sound	Hobe Sound Utility
15	775600	1006300	Hydratech	Hydratech Utility
16	795900	958350	Tequesta	Tequesta Utility
17	724500	1031500	Martin Downs	Martin Downs Utility
18	643900	986400	FPL1	Florida Power & Light
19	640550	976000	FPL2	
20	633800	970500	FPL3	
21	630900	974400	FPL4	
22	629450	983300	FPL5	
23	628900	987500	FPL6	
24	627250	995700	FPL7	
25	641000	996000	FLP8	
26	761510	1015140	Mt Co Dixie Park	Martin County Utility
27	724900	1049900	Harbour Ridge	Harbour Ridge Utility
28	737700	1022400	Pipers Landing	Pipers Landing Utility
29	755500	993500	HSL B14	Hobe St. Lucie Conservancy District
30	748000	975500	HSL B12	
31	761000	972500	HSL B13	
32	796200	941200	Jonathan's Landing	Jonathans Landing Golf Maintenance

TABLE D-1: Rainfall Station Descriptions (Continued)

Map No.	State Plane Coordinates		Rainfall Station	Source
	East	North		
33	758300	963000	Old Trail (West)	Old Trail Golf Maintenance
34	760700	959800	Old Trail (East)	Old Trail Golf Maintenance
35	763400	935800	SIRWCD	South Indian River Water Control Dist.
36	679250	997800	Troup Ind. WCD 801	Coca-Cola Groves - Indiantown
37	679300	1003000	Troup Ind. WCD 803	
38	679300	1008500	Troup Ind. WCD 805	
39	687500	984900	Troup Ind. WCD 814	
40	689750	993900	Troup Ind. WCD 817	
41	690100	1001900	Troup Ind. WCD 820	
42	689750	978800	Robinson Blk 1	Indian Sun Groves
43	689700	974200	Robinson Blk 8	
44	690300	972050	Robinson Blk 12	
45	689050	975300	Robinson Blk 21	
46	685600	975400	Robinson Blk 27	
47	683400	975600	Robinson Blk 30	
48	680750	972100	Chastain Blk 1	
49	684500	973400	Chastain Blk 6	Indian Sun Groves
50	684400	970700	Chastain Blk 8	
51	688000	970800	Chastain Blk 11	
52	687100	968800	Chastain Blk 13	
53	691900	969900	Chastain Blk 17	
54	689700	967400	Chastain Blk 19	
55	691000	964800	Chastain Blk 21	
56	684300	987300	CircleT Blk 2	Indian Sun Groves
57	682200	987300	CircleT Blk 9	
58	678200	987300	CircleT Blk 21	
59	674600	989550	CircleT Blk 35	
60	678200	989550	CircleT Blk 48	
61	681800	989550	CircleT Blk 55	Martin County Solid Waste Facility
62	705456	1034067	Martin Co. Landfill	

TABLE D-2: S.F.W.M.D. Land Use and Land Cover Classification Code

LEVEL I LEVEL II LEVEL III

(U) Urban and built-up land

(UR) Residential

- (URSL) Single-family, Low Density (under 2 D.U./gross acre)
- (URSM) Single-family, Medium Density (2 to 5 D.U./gross acre)
- (URSH) Single-family, High Density (over 5 D.U./gross acre)
- (URMF) Multi-family building
- (URMH) Mobile homes

(UC) Commercial and Services

- (UCPL) Parking lot
- (UCSC) Shopping center
- (UCSS) Sales and services
- (UCCE) Cultural and Entertainment
- (UCMC) Marine commercial (Marinas)
- (UCHM) Hotel-Motel

(UI) Industrial

- (UIJK) Junkyard
- (UILT) Other light industrial
- (UIHV) Other heavy industrial

(US) Institutional

- (USED) Educational
- (USMD) Medical
- (USRL) Religious
- (USMF) Military
- (USCF) Correctional
- (USGF) Governmental (other than military or correctional)
- (USSS) Social services (Elks, Moose, Eagles)

(UT) Transportation

- (UTAP) Airports
- (UTAG) Small grass airports
- (UTRR) Railroad yards and terminals
- (UTPF) Port facilities
- (UTEP) Electrical power facilities
- (UTTL) Major transmission lines
- (UTHW) Major highway and rights-of-way
- (UTWS) Water supply plants
- (UTSP) Sewerage treatment plants
- (UTSW) Solid waste disposal

TABLE D-2: S.F.W.M.D. Land Use and Land Cover Classification Code (Continued)

(UTRS)	Antenna arrays
(UTOG)	Oil and gas storage
(UO)	Open and others
(UORC)	Recreational facilities
(UOGC)	Golf courses
(UOPK)	Parks
(UOCM)	Cemeteries
(UORV)	Recreational vehicle parks
(UOUD)	Open under development
(UOUN)	Open and undeveloped within urban area

(A) Agriculture

(AC) Cropland

(ACSC)	Sugar cane
(ACTC)	Truck crops
(ACRF)	Rice fields

(AP) Pasture

(APIM)	Improved pasture
(APUN)	Unimproved pasture

(AM) Groves, Ornamentals, Nurseries, Tropical fruits

(AMCT)	Citrus
(AMTF)	Tropical fruits
(AMSF)	Sod farms
(AMOR)	Ornamentals

(AF) Confined feeding operations

(AFFL)	Cattle feed lots
(AFDF)	Dairy farms
(AFFF)	Fish farms
(AFHT)	Horse training and stables
(AFPY)	Poultry

(R) Rangeland

(RG) Grassland

(RS) Scrub and brushland

(RSPP)	Palmetto prairies
(RSSB)	Brushland

(F) Forested uplands

TABLE D-2: S.F.W.M.D. Land Use and Land Cover Classification Code (Continued)

(FE) Coniferous

- (FEPF)** Pine flatwoods
- (FESP)** Sand pine scrub
- (FECF)** Commercial forest (pine)

(FO) Non-coniferous

- (FOAP)** Australian pine
- (FOBP)** Brazilian pepper
- (FOPA)** Palms
- (FOSO)** Scrub oak
- (FOOK)** Oak
- (FOCF)** Commercial forest

(FM) Mixed forested

- (FMTW)** Temperate hardwoods
- (FMCM)** Cabbage palms/Melaleuca
- (FMCO)** Cabbage palms/Oaks
- (FMPM)** Pine/Melaleuca
- (FMPO)** Pine/Oak
- (FMTH)** Tropical hammocks
- (FMOF)** Old fields forested
- (FMCD)** Coastal dunes
- (FMPC)** Pine/Cabbage palms

(W) Wetlands

(WF) Forested fresh

- (WFCM)** Cypress/Melaleuca
- (WFCY)** Cypress
- (WFWL)** Willow
- (WFME)** Melaleuca
- (WFSB)** Scrub and brushland
- (WFMX)** Mixed forested

(WN) Non-forested fresh

- (WNSG)** Sawgrass
- (WNCT)** Cattail
- (WNBR)** Bullrush
- (WNWC)** Wire cordgrass
- (WNAG)** Mixed aquatic grass
- (WNWL)** Sloughs

(WS) Forested salt

- (WSRM)** Red mangrove
- (WSBW)** Black and White mangrove

(WM) Non-forested salt

TABLE D-2: S.F.W.M.D. Land Use and Land Cover Classification Code (Continued)

(WX) Mixed forested and non-forested fresh

(WXPP) Pine and wet prairies

(WXCP) Cypress domes and wet prairies

(WXHM) Hardwood marsh

(H) Water

(B) Barren land

(BB) Beaches

(BP) Extractive

(strip mines, quarries, and
gravel pits)

(BS) Spoil areas

(BL) Levees

* Documentation of major codes from "LAND USE, COVER AND FORMS CLASSIFICATION SYSTEM, A TECHNICAL MANUAL", Department of Transportation, State Topographic Office Remote Sensing Center, Kuyper, Becker and Shopmyer, February 1981

TABLE D-3: Coefficients Used in Recharge Preprocessing

Land Use	Ki	Ks	Ka
U	.75	.10	.10
UR	.70	.10	.10
URSL	.80	.10	.10
URSM	.75	.10	.10
URSH	.70	.10	.10
URMF	.65	.10	.10
URMH	.60	.10	.10
UC	.50	.30	.10
UCPL	.50	.30	.10
UCSC	.50	.30	.10
UCSS	.50	.30	.10
UCCE	.60	.20	.10
UCMC	.50	.20	.10
UCHM	.50	.20	.10
UI	.50	.30	.10
UIJK	.50	.30	.10
UILT	.50	.20	.10
UIHV	.50	.30	.10
US	.50	.20	.10
USED	.60	.20	.10
USMD	.50	.30	.10
USR	.50	.20	.10
USMF	.50	.20	.10
USCF	.50	.20	.10
USGF	.50	.20	.10
USSS	.50	.20	.10
UT	.60	.20	.10
UTAP	.60	.20	.10
UTAG	.70	.10	.10

Land Use	Ki	Ks	Ka
AMOR	.70	.10	.10
AF	.90	.10	.10
AFFL	.90	.10	.10
AFDF	.90	.10	.10
AFFF	.90	.10	.10
AFHT	.90	.10	.10
AFPY	.90	.10	.10
R	.75	.10	.10
RG	1.00	.10	.10
RS	.80	.10	.10
RSPP	.75	.10	.10
RSSB	.80	.10	.10
F	.85	.10	.10
FE	.85	.10	.10
FEPF	.85	.10	.10
FESP	.85	.10	.10
FECP	.85	.10	.10
FO	.85	.10	.10
FOAP	.85	.10	.10
FOBP	.85	.10	.10
FOPA	.85	.10	.10
FOSO	.85	.10	.10
FOOK	.85	.10	.10
FOCF	.85	.10	.10
FM	.85	.10	.10
FMTW	.85	.10	.10
FMCM	.85	.10	.10
FMCO	.85	.10	.10
FMPM	.85	.10	.10

TABLE D-3: Coefficients Used in Recharge Preprocessing (Continued)

Land Use	Ki	Ks	Ka
UTRR	.60	.10	.10
UTPF	.60	.20	.10
UTEP	.60	.10	.10
UTTL	.60	.10	.10
UTHW	.60	.10	.10
UTWS	.60	.10	.10
UTSP	.60	.20	.10
UTSW	.60	.10	.10
UTRS	.60	.10	.10
UTOG	.60	.20	.10
UO	.98	.10	.10
UORC	.90	.10	.10
UOGC	.75	.10	.10
UOPK	.90	.10	.10
UOCM	.90	.10	.10
UORV	.80	.20	.10
UOUD	.98	.10	.10
UOUN	.75	.10	.10
A	.80	.10	.10
AC	.95	.10	.10
ACSC	.83	.10	.10
ACTC	.95	.10	.10
ACRF	.86	.10	.10
AP	.83	.10	.10
APIM	.83	.10	.10
APUN	.83	.10	.10
AM	.85	.10	.10
AMCT	.85	.10	.10
AMTF	.85	.10	.10
AMSF	.90	.10	.10

Land Use	Ki	Ks	Ka
FMPO	.85	.10	.10
FMTH	.85	.10	.10
FMOF	.85	.10	.10
FMCD	.85	.10	.10
FMPC	.85	.10	.10
W	.90	.10	.10
WF	.85	.10	.10
WFCM	.85	.10	.10
WFCY	.85	.10	.10
WFWL	.85	.10	.10
WFME	.87	.10	.10
WFSB	.80	.10	.10
WFMX	.80	.10	.10
WN	.90	.10	.10
WNSG	.90	.10	.10
WNCT	.90	.10	.10
WNBR	.90	.10	.10
WNWC	.90	.10	.10
WNAG	.90	.10	.10
WNWL	.90	.10	.10
WS	.85	.10	.10
WSRM	.85	.10	.10
WSBW	.85	.10	.10
WM	.90	.10	.10
WX	.90	.10	.10
WXPP	.90	.10	.10
WXCP	.90	.10	.10
WXHM	.90	.10	.10
H	1.00	.10	.10

TABLE D-4: Crop Coefficients/Land Use Type Coefficients/Percent Coverage

Land Use	Covered %	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
U	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UR	.48	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
URSL	.67	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
URSM	.53	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
URSH	.45	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
URMF	.33	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
URMH	.40	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UC	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UCPL	.25	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UCSC	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UCSS	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UCCE	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UCMC	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UCHM	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UI	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UIJK	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UILT	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UIHV	.05	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
US	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USED	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USMD	.60	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USRL	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USMF	.60	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USCF	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USGF	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
USSS	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UT	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTAP	.10	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80

TABLE D-4: Crop Coefficients/Land Use Type Coefficients/Percent Coverage (Continued)

Land Use	Covered Month												
	%	1	2	3	4	5	6	7	8	9	10	11	12
UTAG	.20	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTRR	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTPF	.05	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTEP	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTTL	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTHW	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTWS	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTSP	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTSW	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTRS	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UTOG	.50	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UO	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UORC	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UOGC	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UOPK	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UOCM	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UORV	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UOUD	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
UOUN	.90	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80
AC	.90	.41	.44	.63	.67	.64	.69	.72	.71	.72	.86	.74	.64
ACSC	.90	.39	.30	.53	.61	.70	.79	.79	.84	.73	.88	.72	.69
ACTC	.85	.44	.71	.82	.78	.53	.49	.57	.44	.71	.82	.78	.53
ACRF	.90	.39	.30	.53	.61	.70	.79	.79	.84	.73	.88	.72	.69
AP	.90	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
APIM	.90	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
APUN	.90	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AM	.85	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AMCT	.85	.63	.66	.68	.70	.71	.71	.71	.71	.7	.68	.67	.64
AMTF	.85	.27	.42	.58	.70	.78	.81	.77	.71	.63	.54	.43	.3
AMSF	.90	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55

TABLE D-4: Crop Coefficients/Land Use Type Coefficients/Percent Coverage (Continued)

Land Use	Covered %	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
AMOR	.85	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AF	.76	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AFFL	.75	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AFDF	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AFFF	.75	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AFHT	.75	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
AFPY	.75	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
R	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
RG	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
RS	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
RSPP	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
RSSB	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
F	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FE	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FEPF	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FESP	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FECF	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FO	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FOAP	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FOBP	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FOPA	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FOSO	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FOOK	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FOCF	.80	.61	.71	.91	1.06	1.13	1.15	1.15	1.14	1.08	.98	.84	.69
FM	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55
FMTW	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55
FMCM	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55
FMCO	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55
FMPM	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55
FMPO	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55

**TABLE D-4: Crop Coefficients/Land Use Type Coefficients/Percent Coverage
(Continued)**

Land Use	Covered		Month											
	%	1	2	3	4	5	6	7	8	9	10	11	12	
FMTH	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55	
FMOF	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55	
FMCD	.80	.49	.57	.73	.87	.67	.92	.92	.91	.87	.79	.67	.55	
FMPC	.80	.49	.57	.73	.85	.67	.92	.92	.91	.87	.79	.67	.55	
W	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WF	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WFCM	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WFCY	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WFWL	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WFME	.80	.73	.84	.99	1.14	1.24	1.30	1.28	1.22	1.14	1.05	.90	.75	
WFSB	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WFMX	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WN	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WNSG	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WNCT	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WNBR	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WNWC	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WNAG	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WNWL	.80	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
WS	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WSRM	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WSBW	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WM	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WX	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WXPP	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WXCP	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
WXHM	.80	.62	.71	.76	.97	1.05	1.11	1.09	1.04	.97	.89	.77	.64	
H	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	
B	1.0	.49	.57	.73	.85	.90	.92	.92	.91	.87	.79	.67	.55	

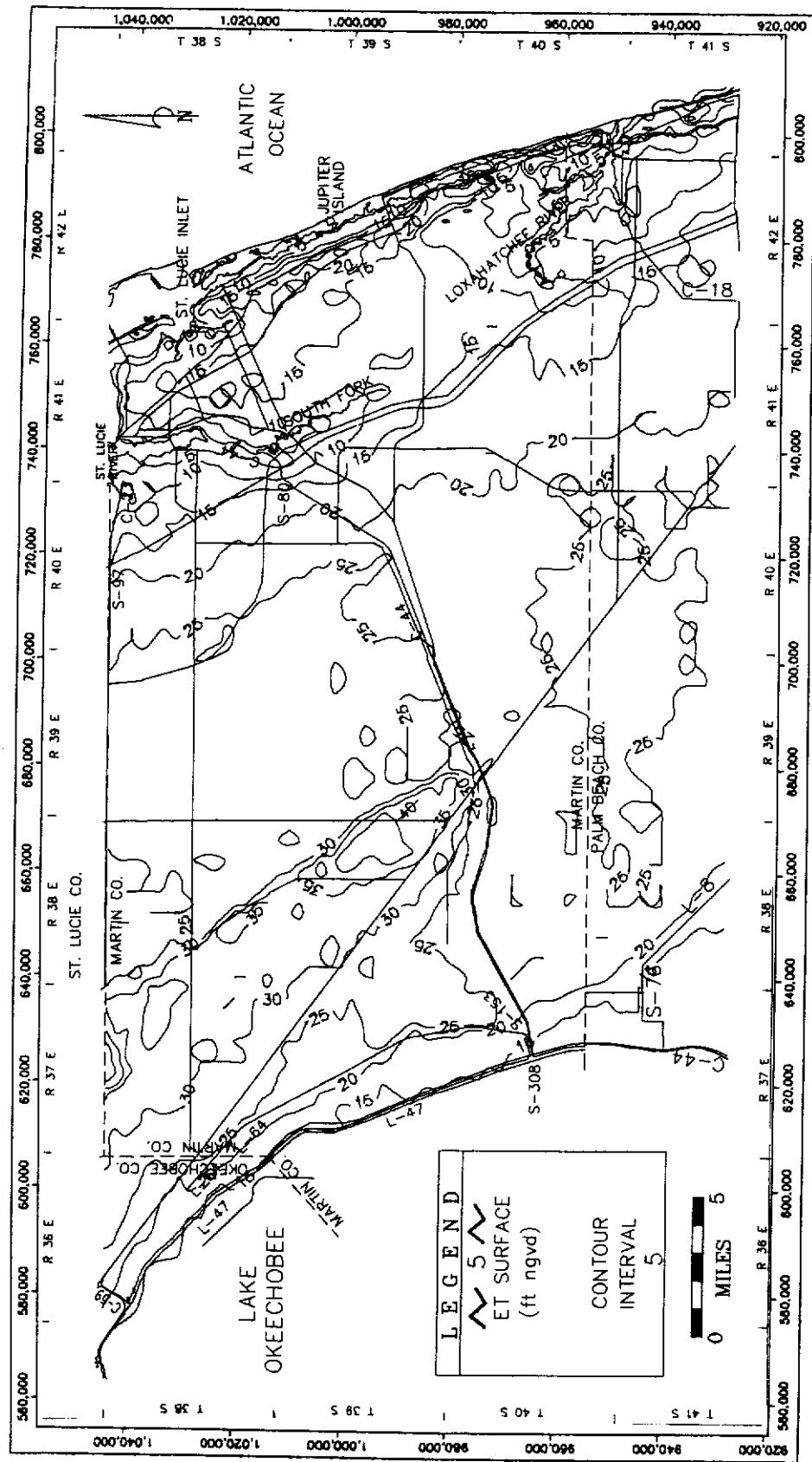


FIGURE D-2: Evapotranspiration Surface

TABLE D-5: Extinction Depths Used in ET Preprocessing

Land Use Code	Extinction Depth (feet)	Land Use Code	Extinction Depth (feet)	Land Use Code	Extinction Depth (feet)
U	1.0	UOGC	1.0	FOCF	2.0
UR	1.0	UOPK	1.25	FM	2.40
URSL	1.0	UOCM	1.0	FMTW	5.0
URSM	1.0	UORV	1.25	FMCM	1.5
URSH	1.0	UOUD	1.0	FMCO	1.5
URMF	1.0	UOUN	1.25	FMFM	2.0
URMH	1.0	A	1.4	FMPO	3.0
UC	1.0	AC	1.65	FMTB	1.5
UCPL	1.0	ACSC	3.0	FMOF	2.0
UCSC	1.0	ACTC	1.0	FMCD	3.0
UCSS	1.0	ACRF	1.0	FMPC	2.0
UCCE	1.0	AP	2.5	W	2.25
UCMC	1.0	APIM	2.5	WF	3.35
UCHM	1.0	APUN	2.5	WFCM	5.0
UI	1.0	AM	2.25	WFCY	6.0
UIJK	1.0	AMCT	3.0	WFWL	1.0
UILT	1.0	AMTF	3.0	WFME	1.5
VIHV	1.0	AMSF	1.25	WFSB	1.5
US	1.0	AMOR	1.6	WFMX	2.5
USED	1.0	AF	1.0	WN	1.5
USMD	1.0	AFEL	1.0	WNSG	2.5
USRL	1.0	AFDF	1.0	WNCT	2.5
USMF	1.0	AFPT	1.0	WNBR	1.0
USCF	1.0	AFHT	1.0	WNWC	1.0
USGF	1.0	AFPY	1.0	WNAG	1.0
USSS	1.0	R	2.0	WNWL	1.0
UT	1.0	RG	2.0	WS	3.0
UTAP	1.0	RS	2.0	WSRM	3.0
UTAG	1.0	RSPP	2.0	WSBW	3.0
UTRR	1.0	RSSB	2.0	WM	1.25
UTPF	1.0	F	2.30	WX	4.0
UTEP	1.0	FE	2.65	WXPP	2.5
UTTL	1.0	FEPF	2.0	WXCP	4.5
UTHW	1.0	FESP	5.0	WXHM	4.5
UTWS	1.0	FECP	1.0	H	6.0
UTSP	1.0	FO	2.0	B	.50
UTSW	1.0	FOAP	1.0		
UTRS	1.0	FOBP	1.0		
UTOG	1.0	FOPA	1.5		
VO	1.10	FOSO	1.5		
UORC	1.0	FOOK	5.0		

APPENDIX E

WATER USE DATA, PUBLIC AND AGRICULTURAL

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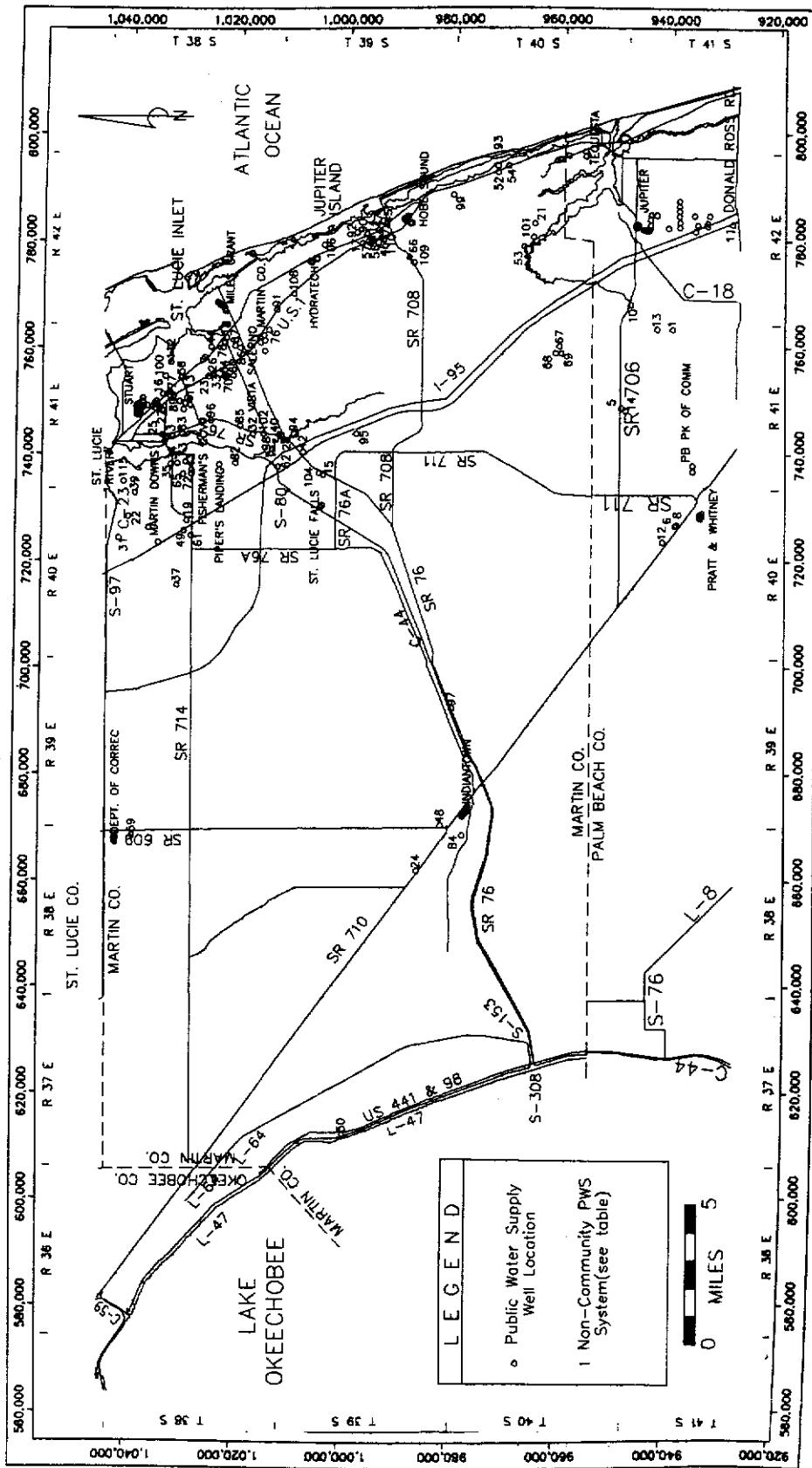


FIGURE E-1: Location of Public Water Supply Utilities

**TABLE E-1-A: Description of Public Supply Utility Wells Used in Model
(Community Systems)**

WELL INDEX	UTILITY NAME	WELL NAME	PUMP CAPAC. (GPM)	ROW	COL	STATE PLANE COORDINATES		PUMPAGE METHODOLOGY AND CALCULATIONS (MT = Monthly Total)
						X	Y	
4300041	INDIANTOWN	1	425	35	41	673149	976576	MT * .293
		2	150	35	41	672809	976797	MT * .103
		3	135	35	41	672611	976588	MT * .093
		4	100	35	41	672238	976679	MT * .069
		5	200	34	40	671830	977061	MT * .138
		6	180	34	40	671568	977312	MT * .124
		7	260	34	40	671283	977530	MT * .179
4300053	STUART	1	180	4	78	746577	1038761	PUMP HOURS * CAPACITY
		2	180	4	78	746643	1038450	
		3	180	4	78	747093	1038788	
		4	140	4	78	746800	1038100	
		5	140	4	78	747677	1038778	
		6	140	4	78	747250	1038100	
		7	140	4	78	747800	1037800	
		8	160	4	79	748280	1038831	
		9	160	4	79	748650	1038395	
		10	180	4	79	748283	1037615	
		11	180	4	79	748990	1037618	
		12	180	4	79	749733	1037625	
		13	180	5	79	748296	1036721	
		15	180	5	79	748716	1035421	
		16	180	5	79	749113	1035098	
		22	180	7	80	750936	1032628	
		23	240	6	79	748503	1034918	
		24	240	5	78	747677	1035211	
		25	240	6	78	747850	1034508	
		26	450	8	79	749640	1029408	
		27	440	9	79	748386	1028789	
		28	520	8	79	749056	1030768	
		29	480	8	78	747536	1030012	
		30	440	8	79	748626	1029729	

**TABLE E-1-A: Description of Public Supply Utility Wells Used in Model
(Community Systems) (Continued)**

WELL INDEX	UTILITY NAME	WELL NAME	PUMP CAPAC. (GPM)	ROW	COL	STATE PLANE COORDINATES		PUMPAGE METHODOLOGY AND CALCULATIONS (MT = Monthly Total)
						X	Y	
4300066	HYDRATECH	2	100	20	92	775676	1006562	MT * .09
		3	100	20	92	775520	1006464	MT * .09
		6	100	20	92	775537	1006625	MT * .09
		4A	250	20	92	775388	1006330	MT * .23
		1A	275	20	93	776015	1005426	MT * .25
		2A	275	20	93	776197	1005356	MT * .25
		SC	100	25	95	780750	996200	MT
4300076	HOBE SOUND	3	500	29	96	783605	988850	MT * .10
		5	500	29	97	784022	988747	MT * .10
		6	500	29	97	784223	988402	MT * .10
		7	500	29	96	783837	988582	MT * .10
		8	500	29	96	783486	988574	MT * .10
		9	500	29	96	783227	988685	MT * .10
		10	450	29	96	783332	988971	MT * .10
		11	500	28	96	783679	989199	MT * .10
		12	500	29	96	782788	988067	MT * .10
		13	500	29	96	782951	987751	MT * .10
4300086	MILES GRANT	1	215	12	88	766016	1022268	PUMP HOURS * CAPACITY
		2	280	12	88	66379	1022402	
		3	160	12	88	766917	1022600	
		4	225	11	88	767095	1023246	
		5	170	11	88	767490	1023410	
		6	215	11	88	767647	1023781	
4300089	MARTIN CO. VISTA SALERNO	2	218	15	85	761200	1015950	MT * .194
		4	225	15	85	760150	1015800	MT * .20
		3	290	15	85	761512	1015146	MT * .258
		6	220	16	85	760547	1014996	MT * .196
		5	170	15	84	758522	1015004	MT * .151
		1A		10	83	757283	1026133	MT * .50
		7B		10	83	756894	1026440	MT * .50
4300164	ST. LUCIE FALLS	1	250	21	69	729415	1004482	MT * .50
		2	125	21	69	729767	1004139	MT * .50

**TABLE E-1-A: Description of Public Supply Utility Wells Used in Model
(Community Systems) (Continued)**

WELL INDEX	UTILITY NAME	WELL NAME	PUMP CAPAC. (GPM)	ROW	COL	STATE PLANE COORDINATES		PUMPAGE METHODOLOGY AND CALCULATIONS (MT = Monthly Total)
						X	Y	
4300169	MARTIN DOWNS	1	700	6	66	722755	1034591	MT * .50
		2	600	5	67	725427	1036453	MT * .50
4300173	PIPER'S LANDING	4	140	11	73	737289	1023301	MT
4300277	DEPT. OF CORRECT.	1	149	2	38	667191	1042246	MT * .25
		2	149	2	38	667123	1042506	MT * .25
		3	149	2	38	666775	1042465	MT * .25
		4	149	2	38	666334	1042317	MT * .25
4300342	FISHERMAN'S COVE	1	250	10	77	745252	1026661	MT * .50
		2	250	10	77	745380	1026312	MT * .50
5000010	JUPITER	1	250	50	96	782450	946080	FLOW METER
		2	250	50	96	782100	946056	
		3	200	50	96	782350	945673	
		4	200	50	96	782050	945859	
		5	200	50	96	782600	945663	
		6	240	51	95	781600	943511	
		7	300	51	95	781500	943698	
		8	300	51	95	781600	944177	
		9	350	51	95	781500	944354	
		10	350	51	95	781600	944700	
		11	300	51	95	781450	943927	
		12	700	51	96	782500	943400	
		13	700	51	96	783550	943400	
		14	500	51	97	784400	943281	
		15	250	54	97	784200	938025	
		16	650	54	97	785162	937992	
		17	550	54	98	786000	938000	
		18	350	54	98	787000	938000	
		19	395	52	97	784350	942200	
		20	360	53	95	781900	940000	
		21	560	54	96	782985	937886	
		22	590	54	96	782073	937938	
		23	500	55	97	784278	935158	

**TABLE E-1-A: Description of Public Supply Utility Wells Used in Model
(Community Systems) (Continued)**

WELL INDEX	UTILITY NAME	WELL NAME	PUMP CAPAC. (GPM)	ROW	COL	STATE PLANE COORDINATES		PUMPAGE METHODOLOGY AND CALCULATIONS (MT = Monthly Total)
						X	Y	
		24	820	57	97	784250	932297	
		25	590	57	96	782826	932699	
		26	340	57	96	782315	932665	
		27	480	56	96	782509	934536	
		28	400	56	95	781300	934941	
5000046	TEQUESTA	7R	750	45	102	795500	955425	FLOW METERS
		8R	750	45	103	796400	955500	
		18	200	43	102	795000	959800	
		19	200	43	102	794900	960200	
		20	200	43	102	794700	960700	
		23	1250	44	102	795600	958600	
5000501	PRATT & WHITNEY	2	250	56	68	727550	933800	MT * .37
		3	250	56	68	727900	933800	MT * .37
		4	150	56	69	728250	933800	MT * .19
		7	250	56	69	728000	933400	MT * .04
		8	250	56	69	728500	933400	MT * .04
5001528	PB PK OF COMM	1		55	73	736400	935200	FLOW METERS
		2		55	73	737500	935200	

**TABLE E-1-B: Description of Public Supply Utility Wells Used in Model
(Non-Community Systems)**

Map #	Utility Name	Model Row	Model Column	Population Served	State Plane Coordinates	
					East	North
Palm Beach County (north of Donald Ross Road)						
10	S & S Rentals (Sierra Sq)	50	88	25	767585	946953
11	Sunshine Tree School	59	96	25	782596	927923
12	Tri-Gas	53	66	25	723095	940783
13	Valmaron Country Store	52	86	25	762967	942000
14	West Jupiter Campground	49	78	25	747800	947800
Martin County (not including Jensen Peninsula)						
15	Ackels MHP	21	72	275	735500	1004000
16	Airport Bus. Park	5	80	124	750434	1033914
17	Angle Inn MHP	24	94	108	779000	997000
18	Anton's Plaza	12	85	25	761077	1022065
19	Armellini Truck	8	68	25	726796	1029333
21	Camp Welaka	41	98	200	782884	964852
22	Canoe Creek	3	68	310	727549	1040243
23	Casa Roma Rest.	10	81	25	753700	1025452
24	Caulkins Indiantown	31	35	65	660940	986004
25	Circle K-Kanner	6	76	25	742850	1033950
26	Coral Gardens Shp. Ctr.	11	82	74	754100	1024650
27	Country Place Rest.	6	78	25	747500	1034000
28	Crestwood Condo	17	76	40	742800	1011760
31	Evergreen Club	2	66	100	723500	1042054
32	Fairmont Estates	14	76	128	743000	1017100
33	Farms Store	11	82	40	754250	1024447
34	First Assembly of God	7	73	88	737535	1031110
35	First Nat'l Bank/Trust	7	73	25	737400	1032300
37	Florida Fisheries	7	62	25	714700	1031088
39	Fox Run	4	71		732000	1039000
40	Fraternal Order of Eagles	17	76	25	742900	1012200
42	Greentree MHP	19	74	186	739744	1007702
43	Heritage Square	9	73	25	736200	1028500
44	Hidden Harbor MHP	11	84	380	759252	1024982
45	Hobe Sound Bible College	26	96	315	783321	993231

**TABLE E-1-B: Description of Public Supply Utility Wells Used in Model
(Non-Community Systems) (Continued)**

Map #	Utility Name	Model Row	Model Column	Population Served	State Plane Coordinates	
					East	North
46	Hobe Sound MHP	26	94	318	779200	994000
47	Hobe Village MHP	26	95	140	781500	994000
48	Indianwood Golf/CC	32	39	25	669531	981600
49	Interstate Ind. Park	8	67	100	724897	1029827
50	J & S Fish Camp	23	10	70	611100	999600
52	JDSP-Pine Grove	37	101	75	792500	971800
53	JDSP-River Area	40	94	25	778500	966800
54	J/T Church of Christ	38	101	444	793705	969876
56	Lakeside Village MHP	25	94	200	779000	995500
57	La Ruche Rest.	25	94	125	779350	995900
58	Li'l Saints-Golden Gate	8	81	100	753497	1030401
59	Martin Co. Min. Security	3	38	100	667593	1039144
60	Meyer Mobile Est.	13	81	170	753858	1020808
61	Midnight Farms Store	9	67	25	724001	1028509
62	Monterey Marine	17	73	30	736921	1012425
63	Monterey Motel	6	75	48	741600	1033500
64	Natalie Estates MHP	12	81	310	753740	1022500
65	New Life Ch of Christ	8	72	585	735500	1030000
66	Nichols Sanitation	29	93	65	776500	988200
67	Old Trail-Clubhouse	43	84	400	759844	960055
68	Old Trail-Golf Maint. Bldg	43	84	25	758500	960800
69	Old Trail-Sales Tr.	43	84	25	758500	959700
70	Open Gate Trailer Park	12	81	55	753833	1022000
72	Palm City Elem.	9	72	750	735550	1028500
73	Palm City Plaza	8	73		737800	1029600
74	Palms Motel	26	95	90	780065	993511
76	Pinelake Gardens	16	86	25	762500	1014207
77	Pines MHP	7	80	120	750133	1032548
78	Port Salerno Groc.	12	85	200	760178	1022450
82	River Landing	13	73	417	737600	1020300
83	Riverland MHP	8	76	420	743000	1030200
84	Rogers Quarters/Booker Pk	34	38	343	667700	977540
85	Ronny's Mobil Ranch	13	77	156	744500	1019500

**TABLE E-1-B: Description of Public Supply Utility Wells Used in Model
(Non-Community Systems) (Continued)**

Map #	Utility Name	Model Row	Model Column	Population Served	State Plane Coordinates	
					East	North
86	Salerno Tr. Pk (Old)	13	84	60	759100	1019500
87	Salerno Tr. Pk (New)	13	84	140	759500	1020468
89	Scotty's-Stuart	7	80	71	750176	1031893
90	Sea Breeze Mobile Man.	25	94	250	779500	995400
91	Seabridge Builders	17	88	30	766400	1012750
92	Soundings Y&CC	24	95	210	781000	998000
93	South End Improv.	37	101	158	793691	971896
94	South Fork Homeowners	18	76	400	743083	1009432
95	South Fork HS	24	76	1800	743152	997921
96	South River Condo	11	77	200	745525	1024900
97	St. Lucie Mob Vill.	33	50	550	691600	979650
98	St. Lucie Settlement	16	75	40	740200	1013400
99	STOP Camp (JDSP)	33	99	28	788206	980036
100	Stuart Aviation Ctr.	6	81	50	753779	1033430
101	Tannah Keeta Camp	40	95	200	780259	965036
102	Ted Twist Tank&Tummy	15	76	50	743044	1015096
104	Towering Pines MHP	21	72	68	735800	1004700
106	Treasure Cove	21	94	58	778664	1004000
108	win Rivers MHP	18	90	60	769506	1009600
109	Tylander Systems	29	92	30	775500	987300
110	Vacation Park	26	94	177	779800	993050
112	Willoughby Creek Townhouses	7	83	35	756400	1032400
113	Willoughby Golf	9	79		749500	1028800
114	Woodbridge Mobile Vill	26	94	189	779500	995000
115	Woodside Subdiv.	2	71	25	734135	1041189

TABLE E-2: Public Water Supply Utility Pumpage Data

UTILITY NAME	WELL # or MAP #	1989 PUMPAGE IN MILLION GALLONS PER MONTH												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg
Community Systems (Large Utilities)														
INDIANTOWN	1	5.706	5.389	5.965	5.824	6.795	5.977	5.607	5.902	5.259	5.226	6.167	7.316	5.928
	2	2.006	1.894	2.097	2.047	2.389	2.101	1.971	2.075	1.849	1.837	2.168	2.572	2.084
	3	1.811	1.710	1.893	1.849	2.157	1.897	1.780	1.873	1.669	1.659	1.958	2.322	1.881
	4	1.344	1.269	1.405	1.372	1.600	1.407	1.321	1.390	1.238	1.231	1.452	1.723	1.396
	5	2.687	2.538	2.810	2.743	3.200	2.815	2.641	2.780	2.477	2.461	2.905	3.446	2.792
	6	2.415	2.281	2.525	2.465	2.876	2.529	2.373	2.498	2.226	2.212	2.610	3.096	2.509
	7	3.486	3.292	3.644	3.558	4.151	3.651	3.426	3.606	3.213	3.193	3.768	4.469	3.621
STUART	1	3.618	3.341	4.597	4.521	4.896	3.023	3.770	3.197	4.105	3.876	4.409	4.295	3.971
	2	5.006	3.271	1.051	0.182	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.793
	3	4.040	4.572	4.160	4.809	4.884	4.609	4.052	3.830	3.965	3.571	4.594	4.007	4.258
	4	3.647	3.921	1.618	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.777
	5	3.294	1.906	3.938	3.068	2.224	3.617	3.855	3.522	3.024	2.405	3.167	3.577	3.133
	6	3.647	4.108	1.618	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.793
	7	3.647	3.916	1.618	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.777
	8	3.793	3.371	4.218	3.689	3.749	4.239	3.298	3.431	2.840	2.838	4.238	3.627	3.611
	9	3.620	0.000	4.228	4.165	4.414	3.959	3.843	2.877	3.374	3.225	3.420	4.088	3.434
	10	1.630	1.882	4.103	3.439	5.041	3.753	1.594	1.757	1.065	1.642	2.401	0.944	2.438
	11	0.000	0.000	3.876	3.439	5.041	3.753	1.594	1.757	1.065	1.642	2.401	0.944	2.126
	12	1.630	1.882	4.103	3.439	5.041	3.753	1.594	1.757	1.065	1.642	2.401	0.944	2.438
	13	1.630	1.882	4.103	3.439	5.041	3.753	1.594	1.757	1.065	1.642	2.401	0.944	2.438
	15	0.000	0.000	0.000	1.246	5.041	3.753	1.594	1.757	1.065	1.642	2.401	0.944	1.620
	16	2.859	1.823	2.728	3.945	3.407	3.201	2.262	2.771	2.706	3.137	2.406	4.489	2.978
	22	3.940	3.411	3.120	4.421	5.198	4.775	3.896	3.602	3.883	3.566	4.184	5.863	4.155
	23	5.999	6.760	6.334	7.596	7.727	6.208	5.355	5.885	6.203	6.815	6.708	7.817	6.617
	24	5.647	5.533	4.524	5.910	7.266	6.485	5.503	6.954	5.564	5.484	5.534	2.398	5.567
	25	7.469	6.526	5.660	6.671	7.450	7.127	6.568	6.789	6.474	7.018	7.217	7.580	6.879
	26	14.320	16.149	10.257	7.408	0.000	0.000	7.389	12.260	12.115	15.050	14.542	13.871	10.280
	27	8.587	13.569	13.905	13.940	12.676	10.931	11.551	9.931	11.420	10.771	12.025	13.870	11.931
	28	6.720	6.960	8.274	7.931	9.569	7.257	6.099	6.490	6.587	8.198	7.162	6.030	7.273
	29	7.342	8.472	7.668	6.757	5.380	7.887	6.649	6.519	5.525	5.807	6.043	7.608	6.805
	30	6.215	5.746	9.599	9.858	12.153	11.715	10.543	4.560	9.290	10.730	13.547	12.460	9.701
HYDRATECH	2	2.303	2.237	2.415	2.465	2.800	2.717	2.500	2.444	2.760	2.547	2.665	2.498	2.529
	3	2.303	2.237	2.415	2.465	2.800	2.717	2.500	2.444	2.760	2.547	2.665	2.498	2.529
	6	2.303	2.237	2.415	2.465	2.800	2.717	2.500	2.444	2.760	2.547	2.665	2.498	2.529
	4A	5.884	5.718	6.171	6.299	7.155	6.944	6.389	6.245	7.054	6.510	6.811	6.383	6.464
	1A	6.396	6.215	6.708	6.847	7.778	7.548	6.945	6.789	7.668	7.076	7.403	6.938	7.026

TABLE E-2: Public Water Supply Utility Pumpage Data (Continued)

UTILITY NAME	WELL # or MAP #	1989 PUMPAGE IN MILLION GALLONS PER MONTH												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg
	3	7.487	5.415	0.833	1.375	0.732	1.319	0.552	1.307	1.075	0.881	3.563	0.504	2.087
	4	0	0	0	0	0	0	0	0	0	0	0	0	0.000
	5	8.799	6.587	1.8	1.831	1.947	1.696	0.734	1.661	1.703	1.111	3.054	0.554	2.623
	6	4.323	3.088	6.009	1.65	8.38	6.371	4.088	4.7	5.007	5.406	4.227	11.079	5.361
	7	5.308	2.662	4.21	0.933	8.105	6.463	3.13	1.612	7.518	6.494	4.484	12.617	5.295
	8	6.066	3.055	6.548	5.003	7.721	5.243	2.39	4.912	6.942	5.266	8.514	9.32	5.932
	9	11.321	8.154	2.836	7.68	11.486	9.251	7.697	5.158	9.626	8.248	12.293	13.177	8.911
	10	7.55	10.624	2.698	7.49	11.515	9.669	6.153	4.321	8.547	9.041	10.489	12.615	8.393
	11	8.862	10.669	2.968	2.696	11.045	9.65	5.959	8.076	8.818	8.435	11.056	10.908	8.262
	12	25.082	22.172	18.927	24.24	24.437	23.402	21.787	23.957	17.663	20.591	20.336	17.268	21.655
	13	13.164	12.062	17.152	16.16	17.415	14.383	11.171	14.029	17.651	14.39	15.719	14.878	14.848
	14	1.377	0	0	0	4.143	9.956	8.935	9.692	9.933	9.814	9.084	5.456	5.699
	15	8.185	12.841	10.392	12.721	13.389	13.274	12.855	12.948	12.636	11.598	11.762	10.057	11.888
	16	14.298	12.509	12.05	10.434	12.95	11.309	11.499	11.409	9.288	8.501	7.733	6.612	10.716
	17	9.442	9.775	9.808	10.09	7.969	11.515	11.739	11.914	11.446	11.703	11.119	9.672	10.516
	18	0.465	0.816	0.693	0.184	2.831	2.526	0.944	0.445	0.307	0.861	0.612	0.668	0.946
	19	12.245	11.556	11.837	12.565	12.779	13.585	14.264	14.403	14.206	13.381	13.809	9.057	12.807
	20	15.328	14.534	15.762	12.339	15.05	15.415	16.576	16.015	14.483	15.957	15.291	10.731	14.790
	21	20.887	20.474	22.199	21.324	21.175	21.662	18	0.371	0	0	0.098	6.852	12.754
	22	18.683	17.364	14.945	15.744	18.741	17.797	15.267	16.628	16.318	16.714	16.568	16.509	16.773
	23	21.918	20.354	22.308	22.164	21.912	21.994	21.094	21.908	22.11	22.493	22.03	21.583	21.822
	24	24.817	20.607	25.292	24.221	25.823	25.012	23.824	24.153	22.599	20.615	23.43	22.109	23.542
	25	22.309	19.093	20.628	18.683	19.753	19.169	19.573	16.991	17.657	17.357	16.827	16.216	18.688
	26	13.999	11.424	13.674	12.087	12.428	10.386	12.464	11.241	11.013	11.699	13.15	12.137	12.142
	27	23.095	21.623	22.066	22.582	24.29	23.962	24.406	22.103	20.163	22.853	22.872	19.301	22.443
	28	9.832	9.084	10.457	9.911	9.783	9.143	9.748	9.985	9.25	9.075	8.543	6.375	9.266
TEQUESTA	7R	16.839	15.842	15.839	9.712	3.628	16.971	6.77	13.241	12.69	5.51	13.854	13.984	12.073
	8R	0	0	0	8.376	15.38	24.836	22.681	3.936	3.863	9.203	0.002	3.3	7.631
	18	0.328	0.299	0.03	1.163	0.326	1.46	2.762	4.212	2.791	4.851	3.453	3.89	2.130
	19	0.03	0	0.036	0.209	0.1	0.559	2.538	1.795	0.892	0	0.002	0.003	0.514
	20	1.571	1.471	1.027	1.246	1.212	2.036	2.668	3.539	3.716	5.062	4.188	3.178	2.576
	23	36.92	30.805	33.92	32.617	34.946	19.814	0	17.939	20.225	15.404	17.856	10.612	22.588
PRATT & WHITNEY	2	11.259	10.811	12.018	12.520	12.994	12.562	11.070	11.222	10.869	10.408	10.356	10.275	11.364
	3	11.259	10.811	12.018	12.520	12.994	12.562	11.070	11.222	10.869	10.408	10.356	10.275	11.364
	4	5.782	5.552	6.171	6.429	6.673	6.451	5.685	5.763	5.581	5.345	5.318	5.276	5.835
	7	1.217	1.169	1.299	1.354	1.405	1.358	1.197	1.213	1.175	1.125	1.120	1.111	1.229
	8	1.217	1.169	1.299	1.354	1.405	1.358	1.197	1.213	1.175	1.125	1.120	1.111	1.229
PB PK OF COMM	1	0.166	0.459	0.592	0.729	0.883	0.792	0.297	0.356	0.25	0.656	1.076	0.674	0.578

TABLE E-2: Public Water Supply Utility Pumpage Data (Continued)

UTILITY NAME	WELL # or MAP #	1989 PUMPAGE IN MILLION GALLONS PER MONTH												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg
		2	0.454	0.626	0.247	0.407	0	0	0	0	0	0	0	0.145
Non-Community Systems (Small Utilities) * = Utility outside of model boundary														
S & S Rentals (Sierra Sq)	10	0	0	0	0.004	0.017	0.015	0.021	0.019	0.007	0.006	0.023	0.029	0.012
Sunshine Tree School	11	0.016	0.017	0.039	0.042	0.055	0.02	0.022	0.028	0.028	0.03	0.027	0.022	0.029
Tri-Gas	12	0.007	0.008	0.007	0.006	0.01	0.006	0.007	0.006	0.006	0.009	0.007	0.006	0.007
Valmaron Country Store	13	0.027	0.027	0.021	0.042	0.047	0.053	0.042	0.029	0.025	0.041	0.024	0.031	0.034
West Jupiter Campground	14	0.279	0.367	0.272	0.309	0.293	0.267	0.241	0.187	0.317	0.319	0.367	0.487	0.309
Ackels MHP	15	0.807	1.072	0.945	0.693	0.753	0.585	0.628	0.525	0.624	0.654	0.746	0.757	0.732
Airport Bus. Park	16	0.061	0.052	0.158	0.136	0.107	0.169	0.288	0.103	0.089	0.078	0.113	0.076	0.119
Angle Inn MHP	17	1.022	0.744	0.428	0.879		1.985	1.748	1.926	2.366	1.903	1.591	1.306	1.445
Anton's Plaza	18										0.026	0.031	0.024	0.027
Armillini Truck	19				0.05	0.115	0.097	0.086	0.038	0.056	0.106	0.065	0.097	0.079
Blue Heron MHP *	20	0.136	0.126	0.121	0.099	0.089	0.058	0.071	0.072	0.068	0.055	0.086	0.109	0.091
Camp Weilaka	21	0.191	0.215	0.177	0.168	0.199	0.189	0.295	0.173	0.173	0.154	0.184	0.097	0.185
Canoe Creek	22	1.861	2.178	2.213	2.398	2.964	3.038	2.945	2.39		2.274	2.05	2.538	2.441
Casa Roma Rest.	23	0.017	0.017	0.018	0.011	0.01	0.01	0.002		0.014	0.013	0.012	0.013	0.012
Caulkins Indiantown	24	0.131	0.329	0.227	0.225	0.32	0.294	0.028	0.048	0.089	0.077	0.207	0.555	0.211
Circle K-Kanner	25					0.004	0.004	0.003	0.008	0.009	0.007	0.002	0.003	0.005
Coral Gardens Shp. Cir.	26	0.027	0.023	0.03	0.028	0.028	0.023	0.022	0.03	0.026	0.049	0.037	0.032	0.030
Country Place Rest.	27	0.005	0.004	0.007	0.005	0.003	0.006	0.007	0.008	0.007	0.009	0.008	0.008	0.006
Crestwood Condo	28	0.16	0.12	0.114	0.135	0.159	0.085		0.068	0.086	0.106	0.147	0.186	0.124
De Ja Vu *	29	0.016	0.009	0.011	0.014	0.012	0.015	0.008	0.008	0.006	0.01	0.006	0.011	0.011
Estuary @ N.River Shores *	30	1.872	2.024	2.246	2.649	3.007	3.357	3.574	3.417	2.811	2.959	3.059	2.907	2.824
Evergreen Club	31	0.066	0.053	0.05	0.062	0.062	0.038	0.035	0.037	0.035	0.045	0.047	0.091	0.052
Fairmont Estates	32	0.301	0.28	0.314	0.271	0.263	0.233	0.235	0.247	0.26	0.279	0.326	0.37	0.282
Farms Store	33	0.007	0.005	0.007	0.007	0.006	0.006	0.007	0.007	0.006	0.006	0.005	0.005	0.006
First Assembly of God	34	0.012	0.019	0.014	0.014	0.02	0.012	0.012	0.017	0.027	0.026	0.027	0.055	0.021
First Nat'l Bank/Trust	35	0.007	0.01	0.031	0.026	0.032	0.005	0.007	0.012	0.014	0.018	0.013	0.012	0.016
Fisherman's Haven *	36	1.352	1.327	1.319	1.375	1.627	1.481	1.522	1.415	1.315	1.249	1.294	1.109	1.365
Florida Fisheries	37	0.023	0.024	0.022	0.017	0.017	0.018	0.014	0.014	0.014	0.012	0.001	0.014	0.016
FP&L (Industrial Use)	38	12.972	13.305	14.317	12.603	11.971	20.154	21.514	15.128	13.324	22.058	23.088	24.845	17.107
Fox Run	39	1.076	1.172	1.163	1.279	1.428	1.374	1.123	1.04	1.004	1.156	1.123	1.166	1.175
Fraternal Order of Eagles	40	0.001	0.006	0.007	0.007	0.007	0.005	0.011	0.008	0.005	0.007	0.008		0.007
Garden Villas *	41	0.45	0.413	0.487	0.471	0.667	0.639	0.489	0.458	0.441	0.518	0.631	0.396	0.505
Greentree MHP	42	0.165	0.24	0.203	0.262	0.211	0.173	0.156	0.13	0.15	0.229	0.279	0.308	0.209
Heritage Square	43	0.097	0.099	0.128	0.134	0.062	0.045	0.052	0.062	0.066	0.052	0.046	0.045	0.074
Hidden Harbor MHP	44	1.31	1.322	1.369	1.311	1.342	1.256	1.219	1.226	1.115	1.231	1.316	1.452	1.289
Hobe Sound Bible College	45	2.274	1.969	1.886	1.524	2.148	1.708	1.308	1.46	1.944	1.624	1.715	1.481	1.753

TABLE E-2: Public Water Supply Utility Pumpage Data (Continued)

UTILITY NAME	WELL # or MAP #	1989 PUMPAGE IN MILLION GALLONS PER MONTH												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg
		2A	6.396	6.215	6.708	6.847	7.778	7.548	6.945	6.789	7.668	7.076	7.403	6.938
HOBE SOUND	SC	1.612	1.250	1.497	1.360	0.789	1.912	1.209	2.532	1.683	2.630	2.421	2.389	1.774
	3	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	5	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	6	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	7	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	8	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	9	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	10	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	11	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	12	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
	13	6.818	7.239	5.307	5.166	8.240	8.310	5.153	8.731	10.646	7.170	7.433	6.565	7.231
MILES GRANT	1	0	0.068	0.161	0.761	0.278	0	0.369	0.395	0.317	1.315	0.836	1.063	0.464
	2	0.024	0.063	0.35	0.318	0.164	0	0.089	0.334	0.324	0.586	0.486	0.539	0.273
	3	0.013	0	0	0	0	2.832	1.159	0.636	1.072	0.966	0.662	1.592	0.744
	4	2.25	1.744	2.545	1.322	1.216	0.618	1.544	1.029	1.274	1.865	1.023	1.836	1.522
	5	1.257	1.318	1.557	1.373	1.877	0.517	0.529	1.09	0.848	0.725	0.211	0	0.942
	6	1.933	2.134	1.442	1.406	0.947	0.559	0.724	1.443	2.058	0.952	1.831	0	1.286
MARTIN CO. VISTA SALERNO	2	6.986	6.184	7.061	6.790	7.117	7.039	6.572	6.578	6.426	7.033	7.030	7.034	6.821
	4	7.202	6.375	7.279	7.000	7.338	7.256	6.775	6.781	6.625	7.250	7.247	7.251	7.032
	3	9.290	8.224	9.390	9.030	9.466	9.360	8.740	8.748	8.546	9.353	9.349	9.354	9.071
	6	7.058	6.248	7.133	6.860	7.191	7.111	6.640	6.646	6.492	7.105	7.102	7.106	6.891
	5	5.437	4.813	5.496	5.285	5.540	5.478	5.115	5.120	5.002	5.474	5.471	5.475	5.309
	1A	5.338	6.300	6.020	6.022	6.593	6.458	6.308	5.522	6.756	6.052	6.424	6.401	6.183
	7B	5.338	6.300	6.020	6.022	6.593	6.458	6.308	5.522	6.756	6.052	6.424	6.401	6.183
ST. LUCIE FALLS	1	1.877	1.817	1.869	1.981	2.070	2.056	1.811	1.254	1.223	1.372	1.614	1.546	1.707
	2	1.877	1.817	1.869	1.981	2.070	2.056	1.811	1.254	1.223	1.372	1.614	1.546	1.707
MARTIN DOWNS	1	7.671	7.508	8.434	7.964	8.028	7.672	7.089	6.857	7.143	7.923	8.549	8.786	7.802
	2	7.671	7.508	8.434	7.964	8.028	7.672	7.089	6.857	7.143	7.923	8.549	8.786	7.802
PIPER'S LANDING	4	3.403	3.783	3.86	3.551	3.233	3.199	2.699	2.349	2.512	3.136	3.206	3.865	3.233
DEPT. OF CORRECT.	1	1.939	1.739	1.813	1.719	1.901	1.913	1.860	2.006	1.958	2.223	2.577	2.487	2.011
	2	1.939	1.739	1.813	1.719	1.901	1.913	1.860	2.006	1.958	2.223	2.577	2.487	2.011
	3	1.939	1.739	1.813	1.719	1.901	1.913	1.860	2.006	1.958	2.223	2.577	2.487	2.011
	4	1.939	1.739	1.813	1.719	1.901	1.913	1.860	2.006	1.958	2.223	2.577	2.487	2.011
FISHERMAN'S COVE	1	2.300	2.231	2.462	2.342	2.505	2.439	2.249	2.223	2.153	2.250	2.233	2.267	2.304
	2	2.300	2.231	2.462	2.342	2.505	2.439	2.249	2.223	2.153	2.250	2.233	2.267	2.304
JUPITER	1	0.652	0.331	2.414	2.72	1.85	2.285	1.259	1.963	1.941	1.883	3.578	0.737	1.803
	2	0.638	0.35	2.379	2.895	4.097	2.27	0.925	2.079	2.027	2.803	6.935	0.895	2.358

TABLE E-2: Public Water Supply Utility Pumpage Data (Continued)

UTILITY NAME	WELL # or MAP #	1989 PUMPAGE IN MILLION GALLONS PER MONTH												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg
Hobe Sound MHP	46	1.343	1.266	1.228	1.516	2.353	2.072	1.55	1.757	2.095	1.525	1.636	1.243	1.632
Hobe Village MHP	47	2.206	1.979	2.308	3.259	3.557	3.499	2.986	2.431	2.987	2.611	2.702	2.256	2.732
Indianwood Gold/CC	48	0.042	0.038	0.039	0.041	0.034	0.073	0.037	0.039	0.049	0.058	0.024	0.017	0.041
Interstate Ind. Park	49	0.068	0.07	0.134	0.077	0.09	0.076	0.108	0.099	0.122	0.134	0.09	0.109	0.098
J & S Fish Camp	50	0.026	0.039	0.019	0.014	0.024	0.019	0.009	0.008	0.009	0.01	0.01	0.008	0.016
Jenaen Village Plaza *	51	0.127	0.177	0.2	0.194	0.282	0.242	0.281	0.269		0.355	0.227	0.311	0.242
JDSP-Pine Grove	52	0.275	0.273	0.233	0.193	0.282	0.208	0.158	0.152	0.168	0.175	0.147	0.143	0.201
JDSP-River Area	53	0.232	0.195	0.228	0.277	0.293	0.274	0.236	0.196	0.234	0.162	0.181	0.199	0.226
J/T Church of Christ	54	0	0	0.28	0.201	0.364	0.345	0.176	0.177	0.155	0.113	0.123	0.103	0.170
Lakeside Village MHP	56	1.569	1.032	0.825	1.389	1.348	0.779	0.54	0.578	1.123	0.71	0.703	0.619	0.935
La Ruche Rest.	57	0.034	0.049	0.034	0.038	0.027	0.019	0.016	0.021	0	0.021	0.033	0.028	0.027
Li'l Saints-Golden Gate	58	0.055	0.038	0.037	0.042	0.054	0.053	0.054	0.061	0.044	0.051		0.015	0.046
Martin Co. Min. Security	59	0.432	0.391	0.609	0.458	0.541	1.05	2.419	0.538	0.428	0.554	0.58	0.588	0.716
Meyer Mobile Est.	60	0.425	0.413	0.442	0.357	0.391	0.515	0.382	0.348	0.479	0.563	0.444	0.496	0.438
Midnight Farms Store	61	0.029	0.028	0.058	0.044	0.045	0.064	0.037	0.039	0.037	0.052	0.031	0.028	0.040
Monterey Marine	62			0.013	0.016	0.021	0.022	0.03	0.032	0.024	0.036	0.031	0.024	0.025
Monterey Motel	63	0.028	0.022	0.025	0.015	0.015	0.013	0.016	0.017	0.017	0.02	0.017	0.018	0.019
Natalik Estates MHP	64	1.186	1.236	1.011	0.868	0.955	0.881	0.736	0.658	0.632	0.841	0.9	0.819	0.895
New Life Ch of Christ	65					0.009	0.006	0.015	0.011	0.009	0.007	0.007	0.009	0.009
Nicols Sanitation	66	0.047	0.05	0.069		0.073					0.024	0.022	0.063	0.050
Old Trail-Clubhouse	67	0.124	0.125	0.128	0.1	0.099	0.097	0.141	0.09	0.093	0.144	0.205	0.165	0.126
Old Trail-Golf Maint. Bldg	68	0.199	0.055	0.039	0.039	0.04	0.054	0.065	0.065	0.059	0.068	0.051	0.1	0.070
Old Trail-Sales Tr.	69	0.003	0.001	0.003	0.015	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004
Open Gate Trailer Park	70	0.035	0.042	0.043	0.034	0.033	0.038	0.033	0.037	0.033	0.036	0.032	0.034	0.036
Palm Circle MHP *	71	0.358	0.422	0.312	0.256	0.214	0.202	0.199	0.199	0.223	0.256	0.343		0.271
Palm City Elem.	72	0.193	0.145	0.118	0.246	0.169	0.058	0.033	0.073	0.193	0.227	0.279	0.122	0.155
Palm City Plaza	73	0.046	0.045	0.049	0.055	0.053	0.047	0.05	0.067	0.077	0.062	0.054	0.042	0.054
Palm Motel	74	0.155	0.221	0.232	0.192	0.24	0.185	0.158	0.231	0.252	0.191	0.202	0.198	0.205
Pine Grove Comm. Cir *	75	0.052	0.04	0.043	0.034	0.031	0.022	0.026	0.033	0.032	0.043	0.037	0.046	0.037
Pinelake Gardens	76	2.713	2.695	2.806	3.035	3.681	3.585	2.867	2.39	2.527	2.709	2.566	2.195	2.814
Pines MHP	77	0.202	0.212	0.178	0.202	0.231	0.127	0.18	0.239	0.19	0.102	0.13	0.148	0.178
Port Salerno Groc.	78									0.021	0.02	0.024	0.028	0.023
Rio Commerc. Ctr *	79			0.031	0.018	0.021	0.02	0.011	0.01	0.009	0.022	0.016	0.014	0.017
Rio Trailer Park *	80	0.146	0.185	0.155	0.132	0.126	0.072	0.061	0.088	0.089	0.123	0.135	0.163	0.123
River Club *	81	0.823	0.868	0.964	0.828	0.723	0.598	0.604	0.461	0.48	0.591	0.744	0.841	0.710
River Landing	82	0.841	0.851	1.042	1.199	1.79	1.597	1.348	1.077	0.943	1.206	1.237	1.381	1.209
Riverland MHP	83	0.992	1.019	0.945	0.851	0.85	0.706	0.554	0.525	0.416	0.587	0.793	0.767	0.750
Rogers Quarters/Booker Pk	84	0.119	0.074	0.148	0.101	0.132	0.122	0.149	0.112	0.145	0.086	0.094		0.117

TABLE E-2: Public Water Supply Utility Pumpage Data (Continued)

UTILITY NAME	WELL # or MAP #	1989 PUMPAGE IN MILLION GALLONS PER MONTH												
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Avg
Ronny's Mobil Ranch	85	0.391	0.331	0.286	0.237	0.237	0.26	0.185	0.156	0.167	0.195	0.252	0.26	0.246
Salerno Tr. Pk (Old)	86	0.108	0.158	0.073	0.045	0.025	0.017	0.013	0.031	0.021	0.025	0.03	0.046	0.049
Salerno Tr. Pk (New)	87	0.288	0.31	0.321	0.2	0.121	0.081	0.122	0.091	0.072	0.094	0.141	0.156	0.166
Sandy's MHP *	88	0.049	0.058	0.057	0.052					0.159	0.243	0.226	0.177	0.128
Scotty's-Stuart	89	0.031	0.028	0.041	0.039	0.026	0.019	0.024	0.033	0.059	0.018	0.011	0.022	0.029
Sea Breeze Mobile Man.	90	1.806	1.572	1.207	1.743	2.674	2.549	1.734	1.477	1.902	1.486	1.466	1.024	1.720
Seabridge Builders	91	0.009	0.014	0.014	0.022	0.018	0.069	0.065	0.083	0.057	0.018	0.008	0.061	0.037
Soundings Y&CC	92	3.863	3.757	3.827	3.623	4.626	4.595	3.886	4.165	4.336	4.047	4.185	3.543	4.038
South End Improv.	93	2.972	2.211	1.592	2.416	3.169	3.362	1.915	2.707	2.714	2.206	2.623	1.491	2.448
South Fork Homeowners	94	0.902	0.761	0.963	0.948	0.855	0.813	0.605	0.649	0.641	0.775	0.867	0.852	0.803
South Fork HS	95	0.922	0.735	1.154	0.674	0.766	0.076	0.97	1.088	2.146	1.49	1.345	0.448	0.965
South River Condo	96	2.648	2.601	2.713	2.426	2.14	2.098	2.171	2.209	1.905	2.206	2.418	2.464	2.333
St. Lucie Mob Vill.	97	2.621	2.358	2.68	2.425	2.873	1.816				2.964	2.921	2.629	2.587
St. Lucie Settlement	98	0.38	0.358	0.279	0.297	0.276	0.267	0.288	0.326	0.243	0.234	0.307	0.309	0.297
STOP Camp (JDSP)	99	0.037	0.036	0.043	0.045	0.121	0.15	0.141	0.096	0.077	0.096	0.078	0.05	0.081
Stuart Aviation Cr.	100	0.06	0.015	0.03	0.116	0.096	0.034	0.013	0.019	0.02	0.017	0.016	0.016	0.038
Tannah Keeta Camp	101	0.003	0.001	0.001	0	0	0	0.047	0.031	0.018	0.011	0.028	0.019	0.013
Ted Twist Tank & Tummy	102							0.048		0.057	0.052	0.043		0.050
Towering Pines MHP	104	0.131	0.098	0.118	0.128	0.096	0.103	0.079	0.069	0.063	0.075	0.098	0.097	0.096
Treasure Cove	106	2.982	2.816	2.81	2.88	4.363	3.731	2.902	3.083	3.787	3.234	3.684	2.575	3.237
Tropical Acres MHP *	107	2.384	3.011	2.579	2.749	3.784	3.523	3.112	2.929	3.046	2.28	2.281	1.783	2.788
Twin Rivers MHP	108	0.121	0.118	0.12	0.078	0.044	0.044	0.035	0.023	0.062	0.056	0.077	0.097	0.073
Tylander Systems	109	0.004	0.007	0.004	0.017						0.004	0.004		0.007
Vacation Park	110	0.355	0.377	0.264	0.408	0.344	0.344	0.256	0.22	0.313			0.246	0.313
Vista Del Lago *	111	3.68	3.355		2.56	2.001	2.099	2.263	2.195	2.125	2.44	2.293		2.501
Willoughby Creek Townhouses	112	0.078	0.067	0.079	0.069	0.079	0.071	0.073		0.073	0.073	0.086	0.09	0.076
Willoughby Golf	113	0	0	0	0	0	0.015	0.082	0.022	0.165	0.131	0.052	0.121	0.049
Woodbridge Mobile Vill.	114	0.764	0.582	0.684	0.715	1.019	0.835	0.713	0.731	0.906	0.617	0.67	0.576	0.734
Woodside Subdiv.	115	0.631	0.653	0.613	0.65									0.637
Yankee Trader *	116	0.144	0.123	0.102	0.113	0.122	0.131	0.132	0.126	0.11	0.128	0.092	0.072	0.116

**TABLE E-3: Comparison of Actual Reported Pumpages to Permitted Pumpages
in Public Water Supply Wellfields**

Individual Water Use Permits		Actual ^{**} (mgm)	Permitted (mgm)
Permit #	Permittee		
4300041	INDIANTOWN	242.531	355
4300053	STUART	1257.504	1410
4300066	HYDRATECH	358.520	752
4300076	HOBESOUND	867.761	1070
4300086	MILES GRANT	62.769	72.63
4300089	MARTIN CO. V. SALERNO	569.857	548
4300164	ST. LUCIE FALLS	40.975	92
4300169	MARTIN DOWNS	187.242	614
4300173	PIPER'S LANDING	38.796	36.5
4300277	DEPT. OF CORRECT.	96.536	134
4300342	FISHERMAN'S COVE	55.300	60
5000010	JUPITER	3507.811	4927.5
5000046	TEQUESTA	570.158	941.7
5000501	PRATT & WHITNEY	372.241	105.57
5001528	PB PK OF COMM	8.664	147.28
General Water Use Permits		Actual Avg Day (mgd)	Permitted Avg Day (mgd)
			Permitted Max Day (mgd)
85-5	Ackels MHP	0.0241	0.0210
87-174	Angle Inn MHP	0.0782	0.0200
79-189	Canoe Creek	0.0801	0.0600
85-45	Evergreen Club	0.0017	0.0005
85-15	First Nat'l Bank/Trust	0.0005	0.0002
83-55	Indianwood Golf/CC	0.0013	0.0009
84-98	J & S Fish Camp	0.0005	?
87-81	J/T Church of Christ	0.0067	0.0014
82-407	Martin Co. Min. Security	0.0235	0.0350
88-255	Monterey Marine	0.0008	0.0020
88-5	New Life Ch of Christ	0.0003	0.0014
87-243	Nichols Sanitation	0.0016	0.0015
86-168	Old Trail-Golf Maint. Bldg	0.0023	0.0179
84-216	Palm City Elem.	0.0051	0.0114
80-142	Pinelake Gardens	0.0925	0.0900
43-00497	Pines MHP	0.0059	0.0070
88-339	Port Salerno Groc.	0.0008	0.0010
85-109	Rio Commerc. Ctr *	0.0006	0.0008
83-110	River Landing	0.0398	0.0400
79-211	Soundings Y&CC	0.1327	0.0500
84-111	South End Improv.	0.0805	0.0320
79-194	South Fork HS	0.0324	0.0700
80-157	South River Condo	0.0767	0.0819
88-396	St. Lucie Mob Vill.	0.0853	0.0820
86-214	STOP Camp (JDSP)	0.0027	0.0030
87-272	Stuart Aviation Ctr.	0.0012	0.0009
43-00498	Tannah Keeta Camp	0.0004	0.0160
87-401	Ted Twist Tank&Tummy	0.0016	0.0008
80-56	Tropical Acres MHP *	0.0917	0.0250
87-340	Tylander Systems	0.0002	0.0003
88-311	Willoughby Golf	0.0016	0.0072
81-107	Woodside Subdiv.	0.0212	0.0150
88-205	Yankee Trader *	0.0038	0.0035
87-450	S & S Rentals (Sierra Sq)	0.0004	0.0009
82-392	Sunshine Tree School	0.0009	0.0010
83-052	Tri-Gas	0.0002	0.0008
82-398	Valmaron Country Store	0.0011	0.0100
			?

Note: The General Permits listed are not a complete list of all small public supplies in the model, but only those that actually have SFWMD permits.

* Water Use Permits outside of model area (Jensen Beach Peninsula)

** Units are in million gallons

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits)

Permit No.	Well Name	State Plane Coord.		Lat	Long	Col	Pump Capacity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source of Data	
		East	North																		
Rodriguez	776900	955400	2	45	93	600	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	Sep-Mar 12 hours/day
	774500	954800	2	46	92	750	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16
	775000	954250	2	46	92	600	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16
	777100	954250	2	46	93	750	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16	29.16
Mecca Farms	787800	931850	2	57	98	800	17.8	16.077	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8
	785850	930400	2	58	97	800	17.8	16.077	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8
	787800	9303400	2	58	98	800	17.8	16.077	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8
	789550	9307000	2	58	99	800	17.8	16.077	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8
	9278000	9278000	2	59	97	800	17.8	16.077	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8	17.28	17.8
	783800	9278000	2	59	98	800	30.24	28.224	30.24	29.264	30.24	29.264	30.24	29.264	30.24	29.264	30.24	29.264	30.24	29.264	30.24
	787450	9278000	2	59	98	800	30.24	28.224	30.24	29.264	30.24	29.264	30.24	29.264	30.24	29.264	30.24	29.264	30.24	29.264	30.24
	4300009	1	778667	1001869	2	22	94	125	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	Pumpage Records
	2	778956	1002288	2	22	94	125	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	Pumpage Records
	3	779348	1002245	2	22	94	125	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	0.263	0.268	Pumpage Records
	4300013	5	741731	1035541	2	5	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	
	6	741604	1035300	2	5	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	7	741552	1035075	2	5	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	8	741730	1035168	2	5	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	9	741965	1035335	2	5	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	13	741973	1035201	2	5	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	3	742491	1035541	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	4	742138	1035555	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	10	742309	1035376	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	11	742487	1035194	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	12	742300	10355213	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	14	742658	1035009	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	
	25	742397	1035061	2	5	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	Pumpage Records	

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plane Coord.		Lat	Long	Col	Pump Capacity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Date	Source & Date	
		East	North																			
4300013	2	741985	1034372	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	19	741868	1034177	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
20	741664	1034055	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
21	740799	1034305	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
23	741883	1034566	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
24	741665	1034425	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
26	741902	1034302	2	6	75	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1	742637	1034413	2	6	76	350	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
15	742613	1034616	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
16	742677	1034672	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
17	742286	1034542	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
18	742057	1034093	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
22	742042	1034957	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
26	742024	1034833	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
27	742428	1034697	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
29	742349	1034914	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
30	742349	1034918	2	6	76	30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
4300017	1	746173	1033661	2	6	78	350	0.071	0.144	0.213	0.157	0	0	0	0	0	0.026	0.12	0.21	0.103	Blaney-Cridle	
2	746185	1033347	2	6	78	290	0.041	0.082	0.122	0.09	0	0	0	0	0	0.015	0.069	0.12	0.059			
3	744331	1032782	2	7	77	140	0.028	0.058	0.085	0.063	0	0	0	0	0	0.01	0.048	0.084	0.041			
4	744446	1032688	2	7	77	350	0.071	0.144	0.213	0.157	0	0	0	0	0	0.026	0.12	0.21	0.103			
4300021	4	762317	986255	2	30	86	800	9.055	10.159	18.938	12.037	16.178	13.527	16.288	11.098	8.724	6.57	13.989	9.11	Blaney-Cridle		
5	763368	986183	2	30	86	800	9.055	10.159	18.938	12.037	16.178	13.527	16.288	11.098	8.724	6.57	13.989	9.11				
4300022	2	645473	991177	2	27	175	5.278	5.33	16.436	5.365	5.203	6.718	7.171	6.007	5.588	6.266	5.679	6.011	Pumpage Records			
3	645875	991170	2	27	175	28	175	7.916	7.995	24.655	8.047	7.804	10.077	10.757	9.01	8.381	9.398	8.518	9.017			
1	644643	990373	2	27	28	28	27	28	28	2.639	2.665	2.601	3.359	3.586	3.003	2.794	3.133	2.839	3.006			
4	646340	991159	2	28	27	28	27	28	27	175	175	175	175	175	175	175	175	175	175			
5	646819	991207	2	28	27	28	27	28	27	175	175	175	175	175	175	175	175	175	175			

**TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)**

Permit No.	Well Name	State Plane Coord.		Raw	C4	Pump Capacity	1989 Pumpage in Million Gallons per Month			JUL	AUG	SEP	OCT	NOV	DEC	Source of Data			
		East	North				JAN	FEB	MAR										
4300031	6	647651	991193	2	28	27	175			0.199	0.326	0.198	0.275	0.265	0.236	0.234	0.168		
	1	754382	1036460	2	5	82	20	0.188	0.199	0.326	0.198	0.275	0.265	0.3	0.2	0.236	0.234		
	2	753981	1035097	2	5	82	20	0.188	0.199	0.326	0.198	0.275	0.265	0.3	0.2	0.236	0.168		
	3	757376	1035414	2	5	83	400	3.765	3.985	6.511	3.954	5.491	5.303	6.009	4.001	4.722	5.13		
	4	757275	1034150	2	6	83	200	1.883	1.893	3.255	1.977	2.746	2.651	3.004	2	2.361	4.675	3.357	
	5	757757	1034527	1	6	83	200	1.883	1.993	3.255	1.977	2.746	2.651	3.004	2	2.361	2.356	2.358	
	6	757759	1034298	1	6	83	200	1.883	1.993	3.255	1.977	2.746	2.651	3.004	2	2.361	2.356	2.358	
4300032	1	757390	1028042	2	9	83	1200	12.165	12.875	21.035	12.773	17.741	17.132	19.413	12.925	15.257	16.575	15.105	
																	10.847	Blaney-Criddle	
4300051	1	733137	1007447	2	19	71	200	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504	0.504	
																		Nov-May 3 times/ week, 6-7 hours/day	
4300054	1	793020	964275	2	41	101	350	15.41	15.178	17.66	16.292	20.306	20.157	25.726	26.674	27.523	12.218	22.964	
	2	792993	964489				450											15.919	Pumpage Records
	3	792680	964763				350												
	4	792396	965233	2	40	101	300	10.273	10.118	11.773	10.861	19.67	18.792	17.151	17.783	18.348	8.145	15.31	
	5	792535	965670				350											10.612	
4300055	1	719317	1041182	2	2	64	45	1.642	1.642	1.642	1.642	1.642	1.642	1.642	1.642	1.642	1.642	1.642	
	2	719308	1041264	2	2	64	45												
	3	719355	1041335	2	2	64	35												
	4	719515	1041343	2	2	64	35												
	5	719455	1041269	2	2	64	35												
	6	719412	1041187	2	2	64	35												
	7	719611	1041172	2	2	64	70												
	8	719850	1041166	2	2	64	35												
	17	719877	1041450	2	2	64	100												
	18	719700	1041446	2	2	64	75												
	19	719571	1041611	2	2	64	35	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	
	9	720017	1041157	2	2	65													

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plane Coord.	Lat	Long	C44 Pump Capacity	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source of Data	
																	Pump Hours Records	
4300055	10	720201	1041187	2	65	35												
	14	720412	1041041	2	65	35												
	15	720382	1041231	2	65	35												
	16	720378	1041441	2	65	100												
	11	720240	1040935	2	65	35	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	
	12	720420	1040615	2	65	35												
	13	720436	1040824	2	65	35												
4300057	1	738887	998316	2	24	84	400	7,081	8,139	6,104	8,546	3,093	6,972	3,093	1,953	4,232	2,197	4,314
	2	758060	996966	2	25	84	500	30,094	34,59	25,943	36,32	13,144	29,632	13,144	8,302	17,987	9,339	18,333
	3	758048	996325				500											
	4	758039	995455				500											
	5	758000	994578	2	26	84	450	28,323	32,556	24,417	34,183	12,371	27,889	12,371	7,813	16,929	8,79	17,254
	6	758013	993912				500											
	7	757993	993103				500											
	8	758036	992308	2	27	84	450	17,702	20,347	15,26	21,365	7,732	17,431	7,732	4,883	10,581	5,494	10,581
	9	758066	991419				450											
	11	755822	991367	2	27	82	450	17,702	20,347	15,26	21,365	7,732	17,431	7,732	4,883	10,581	5,494	10,581
	12	755802	992269				450											
	13	755790	993085	2	26	82	350	26,533	30,521	22,891	32,047	11,598	26,146	11,598	7,325	15,871	8,241	15,871
	14	755765	992653				500											
	15	755791	994465				500											
	16	755778	995233	2	25	82	400	26,533	30,521	22,891	32,047	11,598	26,146	11,598	7,325	15,871	8,241	15,871
	17	755802	995957				500											
	18	755754	996777				450											
	19	755741	997706	2	24	82	500	19,472	22,382	16,786	23,501	8,505	19,174	8,505	5,372	11,639	6,043	11,639
	20	755767	998475				450											
	21	747217	985369	2	30	78	700	1,157	10,323	2,136	3,56	0	5,384	3,56	0,801	2,225	2,581	1,246

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plan Card	East	West	Raw	Col	Pump Capacity	1989 Pumpage in Million Gallons per Month						Source of Data					
								Jan	Feb	Mar	Apr	May	Jun	Jul					
4300057	22	745522	985565	2	30	77	450	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	23	745404	984365	2	31	77	500	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	24	745418	982961	2	32	77	450	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	25	745291	980355	2	33	77	500	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	27	741961	980385	2	33	75	450	1.35	12.044	2.492	4.153	0	6.281	4.153	0.934	2.596	3.011	1.454	2.492
	28	740586	980396				400												
	30	738818	980457	2	33	74	450	1.35	12.044	2.492	4.153	0	6.281	4.153	0.934	2.596	3.011	1.454	2.492
	31	738240	980420				450												
	32	737782	980444	2	33	73	450	1.35	12.044	2.492	4.153	0	6.281	4.153	0.934	2.596	3.011	1.454	2.492
	33	737780	979258				400												
	34	737730	978352	2	34	73	500	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	35	738803	978269	2	34	74	500	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	36	740832	978339	2	34	75	450	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	37	742104	978230	2	34	76	450	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	38	745338	978154	2	34	77	400	0.578	5.162	1.068	1.78	0	2.692	1.78	0.4	1.112	1.29	0.623	1.068
	39	753828	970243	2	38	81	500	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	40	754842	970290	2	38	82	500	0.771	6.982	1.424	2.373	0	3.589	2.373	0.534	1.483	1.721	0.831	1.424
	41	756144	970306	2	38	83	550	1.543	13.764	2.848	4.746	0	7.179	4.746	1.068	2.966	3.441	1.661	2.848
	42	757655	970285																
	43	759006	970284	2	38	84	600	0.964	8.603	1.78	2.966	0	4.487	2.966	0.667	1.854	2.151	1.038	1.78
	44	754652	975798	2	35	82	250	1.361	7.484	0.551	2.203	0.486	5.411	0.486	1.426	3.92	1.426	3.92	4.666
	45	763393	975224	2	35	86	500	2.722	14.969	1.102	4.406	0.972	10.822	0.972	2.851	7.841	2.851	7.841	9.331
	46	763393	974338	2	36	86	450	2.449	13.472	0.991	3.966	0.875	9.739	0.875	2.566	7.057	2.566	7.057	8.398
	47	763331	972049	2	37	86	450	4.899	26.944	1.983	7.932	1.75	19.479	1.75	5.132	14.113	5.132	14.113	16.796
	48	763404	971562																
	49	763378	970795	2	38	86	500	5.171	28.441	2.093	8.372	1.847	20.561	1.847	5.417	14.898	5.417	14.898	17.729
	50	763082	969499	2	38	86	450	5.171	28.441	2.093	8.372	1.847	20.561	1.847	5.417	14.898	5.417	14.898	17.729

TABLE E-4-A:

Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plane Coord.		Pump Capacity	1990 Pumpage in Million Gallons per Month						Source of Data									
		East	North		Jan	Feb	Mar	Apr	May	Jun		Oct	Nov	Dec						
4300057	51	763132	968931	2	39	86	500	8,165	44,906	3,305	13,219	2,916	32,465	2,916	8,554	23,522	8,554	23,522	27,994	
	52	763254	968324				500	500												
	53	763260	967507				500													
	54	755517	974734	2	36	82	450	2,449	13,472	0.991	3,966	0.875	9,739	0.875	2,566	7,057	2,566	7,057	8,398	
	55	758743	974887	2	36	84	400	0.578	5,162	1,068	1,780	0	2,692	1,780	0.400	1,112	1,290	0.623	1,068	
	56	748257	971607	2	37	79	600	0.964	8,603	1,780	2,966	0	4,487	2,966	0.667	1,854	2,151	1,038	1,780	
	57	747910	973632	2	36	78	700	1,157	10,323	2,136	3,56	0	5,384	3,56	0.801	2,225	2,581	1,246	2,136	
	58	747323	982304	2	32	78	850	1,35	12,044	2,492	4,153	0	6,281	4,153	0.934	2,596	3,011	1,454	2,492	
4300059	1	744314	1013437	2	16	77	450	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	
	2	744356	1011174	2	17	77	450	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	
	3	747032	1011848	2	17	78	450	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	
4300064	1	767946	1015392	2	15	88	960	11,48	14,827	17,733	15,055	25,181	24,995	23,918	23,776	31,578	16,961	23,286	23,986	Pumpage Records
	2	767922	1015914				350													
	3	767697	1017956	2	14	88	800	7,006	9,049	10,822	9,188	15,468	15,254	14,597	14,511	19,272	10,351	14,211	14,638	
4300069	1	724481	1042801	2	2	67	350	3,272	3,522	6,027	3,726	5,103	4,636	5,432	3,647	3,804	3,773	4,367	3,652	Blaney-Criddle
4300091	1	782998	962208	2	42	96	250	8.8	7.2	8.3	9.2	10.5	10.5	11.1	9.2	10.2	6.95	8.5	0	
4300107	1	750499	1019720	2	13	80	100	1,344	1,344	1,344	1,344	1,344	1,344				1,344	1,344	1,344	Nov-May 2 wells 1 time/ week 14 hours/day
	2	750501	1019815																	
	3	750504	1019913																	
	4	750429	1019879																	
4300132	1	746369	1030916	2	8	78	150	0.117	0.238	0.351	0.259	0	0	0	0	0.042	0.198	0.346	0.17	Blaney-Criddle
4300132	2	746112	1030937	2	8	78	150	0.117	0.238	0.351	0.259	0	0	0	0	0.042	0.198	0.346	0.17	Blaney-Criddle
4300138	4	749747	9555991	2	45	79	125	0.181	0.624	1,014	0.719	0.802	0.808	0.955	0.581	0.498	0.154	0.599	0.565	Blaney-Criddle
	5	749815	9557668	2	45	79	125	0.181	0.624	1,014	0.719	0.802	0.808	0.955	0.581	0.498	0.154	0.599	0.335	
	1	750162	9554668	2	45	80	70	0.101	0.349	0.568	0.403	0.449	0.452	0.535	0.325	0.279	0.086	0.335	0.317	
	2	750220	955307	2	45	80	70	0.101	0.349	0.568	0.403	0.449	0.452	0.535	0.325	0.279	0.086	0.335	0.317	

TABLE E-4-A:

Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plane Coord.	Lat	Lon	Col	Pump Capacity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Date	Source of Data	
1999 Pumpage in Million Gallons per Month																				
4300143	3	750279	955169	2	45	80	70	0.101	0.349	0.568	0.403	0.449	0.452	0.535	0.325	0.279	0.086	0.335	0.317	Pumpage Records Use 4 wells at a time
	1	746270	1029803	2	8	78	200	0	3.187	3.128	2.656	2.25	2.506	1.162	1.005	0.693	0.876	2.058	2.197	
	2	746465	1029997				300													
	3	746490	1029814				50													
	4	746863	1030158				300													
	5	746885	1029893				200													
4300144	6	747194	1028976				300													Now-May
	2	743029	1033498	2	6	76	100	1.134	1.134	1.134	1.134	1.134	1.134	1.134	1.134	1.134	1.134	1.134	1.134	
	1	743706	997554	2	24	76	200	1.232	1.243	1.087	1.863	1.918	0.843	0.922	1.134	2.375	1.698	1.539	0.671	
	2	743533	997158				200													
	1	747820	1028915	2	8	78	150	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	Sep-Jun Every 3rd day, 1.5 hours	
	2	747654	1029107				150													
4300182	1	736312	1025969	2	10	73	300	2.305	3.546	2.994	3.793	3.793	3.793	3.793	3.793	2.177	2.413	2.534	1.533	Pumpage Records - PWS portion
	2	737242	1025728				350													
	3	737232	1024454	2	11	73	450	2.127	3.274	2.764	3.302	3.699	3.451	2.010	2.232	2.339	1.415	3.061	1.093	
	4	737289	1023501				140													
	2	764149	956537	2	45	87	800	24	24	24	24	24	18	0	0	0	0	0	24	Blaney-Criddle
	3	765685	956628	2	45	87	800	24	24	24	24	24	18	0	0	0	0	0	24	
4300200	4	767644	956620	2	45	88	800	24	24	24	24	24	18	0	0	0	0	0	24	Blaney-Criddle
	5	768215	956626	2	45	89	800	24	24	24	24	24	18	0	0	0	0	0	24	
	1	764335	954180	2	46	87	800	24	24	24	24	24	18	0	0	0	0	0	24	
	1	784207	964086	2	41	97	90	0.168	0.27	0.4	0.259	0.316	0.34	0.382	0.24	0.301	0.199	0.25	0.233	
	1	648313	982557	2	32	29	300	1.39	1.944	1.15	1.958	1.721	2.383	1.654	0.944	0.016	0.028	2.275	2.403	
	1	4300206																		

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plan Card	Lat	Long	Col	Pump Capacity	Jan	Feb	Mar	Apr	May	Jun	1969 Pumpage in Millions Gallons per Month				Oct	Nov	Dec	Date	Source of Data		
													Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
4300242	2	725777	1022157	2	13	67	120	1,382	1,382	1,382	1,382	1,382										Jan-May Every 2 weeks, 48 hours on Pumpage Records (well portion)	
	3	725754	1022730				120																
4300251	3	736636	1035034	2	5	73	190	2,72	2,584	2,992	2,976	2,04	2,108	2,584	2,312	1,904	2,312	1,904	1,632	1,768	1,224	1/224	Blaney-Criddle
	4	736681	1035171				175																
4300261	W7558	731712	1041893	2	2	70	250	1,286	1,385	2,37	1,465	2,007	1,846	2,136	1,434	1,496	1,483	1,483	1,717	1,717	1,2	Blaney-Criddle	
	W7557	733901	1041780	2	2	71	250	1,286	1,385	2,37	1,465	2,007	1,846	2,136	1,434	1,496	1,483	1,483	1,717	1,717	1,2	Blaney-Criddle	
	W7559	733522	1042636	2	2	71	250	1,286	1,385	2,37	1,465	2,007	1,846	2,136	1,434	1,496	1,483	1,483	1,717	1,717	1,2	Blaney-Criddle	
4300266	G	746701	1026801	2	10	78	75	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	3,24	Blaney-Criddle	
4300273	D	787825	991712	2	27	98	125	1,594	2,564	3,884	2,461	3,002	3,235	3,636	2,284	2,862	1,893	2,377	2,377	2,219	2,219	Blaney-Criddle	
	A	788541	991063	2	27	99	125	1,594	2,564	3,884	2,461	3,002	3,235	3,636	2,284	2,862	1,893	2,377	2,377	2,219	2,219		
	C	788263	991162	2	27	99	125	1,594	2,564	3,884	2,461	3,002	3,235	3,636	2,284	2,862	1,893	2,377	2,377	2,219	2,219		
	B	789571	989375	2	28	99	125	1,594	2,564	3,884	2,461	3,002	3,235	3,636	2,284	2,862	1,893	2,377	2,377	2,219	2,219		
4300335	1	768220	1001489	2	22	89	350	2,791	6,047	9,07	6,545	0	0	0	0	0	0	0	3,92	9,07	4,253	Blaney-Criddle	
4300362	1	659016	986105	2	30	34	60	1,239	1,596	2,183	2,207	2,654	2,514	2,72	.363	1,241	.769	.2072	.5,555	.5,555	Pumpage Records		
4300368	1	712935	1042744	2	2	61	600	15,891	17,107	25,92	18,096	24,786	22,81	25,92	17,715	18,476	18,324	21,213	21,213	14,826	Blaney-Criddle		
	2	714466	1041877	2	2	62	600	15,891	17,107	25,92	18,096	24,786	22,81	25,92	17,715	18,476	18,324	21,213	21,213	14,826			
4300371	1	777259	990745	2	28	93	200	0,841	1,352	2,006	1,298	1,583	1,706	1,918	1,205	1,509	0,998	1,254	1,254	1,17	Blaney-Criddle		
	2	778148	994759	2	28	94	110	0,462	0,744	1,103	0,714	0,871	0,938	1,055	0,663	0,83	0,549	0,69	0,644	0,644			
	3	777810	992203	2	27	93	110	0,462	0,744	1,103	0,714	0,871	0,938	1,055	0,663	0,83	0,549	0,69	0,644	0,644			
4300375	W-3	755523	987246	2	29	84	90	0,144	1,257	1,719	1,365	0	0	0	0	0	0	0	1,495	0,881	Blaney-Criddle		
	W-4	755769	988577	2	29	84	1000	1,605	13,967	19,105	15,171	0	0	0	0	0	0	0	16,616	9,793			
	W-1	766827	986059	2	30	85	1000	1,605	13,967	19,105	15,171	0	0	0	0	0	0	0	16,616	9,793			
	W-2	769169	986096	2	30	85	75	0,12	1,048	1,433	1,138	0	0	0	0	0	0	0	1,246	0,734			
4300382	1	774127	1010718	2	18	92	350	0,678	0,717	1,172	0,712	0,988	0,955	1,082	0,72	0,85	0,923	0,842	0,694	0,694	Blaney-Criddle		

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plan Code	Lat	Long	Col	Pump Capacity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source of Data	
East	North																			
2	775798	1007920	2	19	92	350	0.678	0.717	1,172	0.712	0.988	0.955	1,082	0.72	0.85	0.923	0.842	0.604		
4300399	6	720914	1006196	2	19	65	250	0.9	0.9	0.9	0.9	0.9				0.9	0.9	0.9	0.9	Oct-May 2 hrs/day
4300409	2	748413	1018936	2	14	79	175	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	7 hours/day, 7 days/week
4300425	1	735883	1019432	2	13	72	300	0.53	0.57	0.976	0.603	0.826	0.76	0.879	0.591	0.616	0.611	0.707	0.404	Blaney-Criddle
4300434	1	695391	1043329	2	1	52	150	0.554	0.596	1.02	0.631	0.864	0.795	0.919	0.617	0.644	0.638	0.739	0.517	Blaney-Criddle
	2	697224	1041894	2	2	53	150	0.554	0.596	1.02	0.631	0.864	0.795	0.919	0.617	0.644	0.638	0.739	0.517	
	3	695656	1037647	2	4	52	150	0.554	0.596	1.02	0.631	0.864	0.795	0.919	0.617	0.644	0.638	0.739	0.517	
4300441	1	765077	1015946	2	15	87	350	0.547	0.579	0.945	0.574	0.797	0.77	0.872	0.581	0.636	0.745	0.679	0.487	Blaney-Criddle Pumpage Records available but combine ground and surface water withdraw als)
	2	766318	1016667	2	15	88	130	0.203	0.215	0.351	0.213	0.296	0.286	0.324	0.216	0.255	0.277	0.252	0.181	
	3	766741	1013331	2	16	88	350	0.547	0.579	0.945	0.574	0.797	0.77	0.872	0.581	0.636	0.745	0.679	0.487	
4	767201	1013526	2	16	88	350	0.547	0.579	0.945	0.574	0.797	0.77	0.872	0.581	0.636	0.745	0.679	0.487		
5	767974	1014930	2	16	88	75	0.117	0.124	0.203	0.123	0.171	0.165	0.187	0.124	0.147	0.16	0.145	0.104		
6	768386	1013946	2	16	89	30	0.047	0.05	0.081	0.049	0.068	0.066	0.075	0.05	0.059	0.064	0.058	0.042		
7	768475	1014371	2	16	89	30	0.047	0.05	0.081	0.049	0.068	0.066	0.075	0.05	0.059	0.064	0.058	0.042		
8	768670	1013920	2	16	89	30	0.047	0.05	0.081	0.049	0.068	0.066	0.075	0.05	0.059	0.064	0.058	0.042		
9	769487	1013813	2	16	89	100	0.156	0.165	0.27	0.164	0.228	0.22	0.249	0.166	0.196	0.213	0.194	0.139		
4300502	3	746056	1032364	2	7	78	90	1.39	1,471	2,404	1.46	2,028	1,958	2,219	1,477	1,744	1,894	1,726	1.24	Blaney-Criddle
5000153	1	783374	938010	2	52	99	25	1.883	2,161	1,656	1,629	2,248	2,248	2,394	2,551	1,557	2,055	2,916	1.296	Pumpage Records
	2	788693	942736	2	52	99	40													
	1	785390	937998	2	54	97	25	1,883	2,161	1,666	1,629	2,248	2,248	2,394	2,551	1,557	2,055	2,916	1.296	
5000223	5	787639	958301	2	44	98	200	0.541	0.605	0.343	0.499	0.249	0.562	0.77	0.249	0.291	2,691			
	9	789047	958120	2	44	99	200	0.632	0.128		0.728	0.968		0.984	0.464	0.784	0.964	0.648	1.73	
5000237	1	795283	939527	2	53	102	700	1,933	3,109	4,613	2,985	3,641	3,923	4,409	2,77	3,471	2,295	2,883	3,227	GW Portion Pumpage Records
	2	793313	941498	2	52	102	450	1,243	1,999	2,965	1,919	2,34	2,522	2,835	1,781	2,231	1,475	1,853	2,075	

**TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)**

Permit No.	Well Name	State Name	County	Lat	Long	Col#	Row	Pump Capacity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source of Data			
																					1000 Pumpage in Millions Gallons per Month			
5000344	8	775558	952701	2	47	92	350	53,568	48,384	53,568	51,84	0	0	0	26,784	53,568	51,84	53,568	51,84	53,568	51,84	July thru April all wells 24 hours/day 7 days/week		
	9	775500	951650	2	47	92	350																	
11	774500	951650	2	47	92	250																		
12	774950	951650	2	47	92	250																		
5	776592	951380	2	47	93	250		31,248	28,224	31,248	30,24	0	0	0	15,624	31,248	30,24	31,248	30,24	31,248	30,24	31,248		
7	776205	951369	2	47	93	600																		
4	776206	950106	2	48	92	400		15,624	14,112	15,624	15,12	0	0	0	7,812	15,624	15,12	15,624	15,12	15,624	15,12	15,624		
2	776546	948900	2	48	93	250		29,016	26,208	28,08	0	0	0	0	14,508	29,016	28,08	29,016	28,08	29,016	28,08	29,016		
3	776577	950075	2	48	93	350																		
5000547	1	773158	950782	2	48	91	400		2,886	2,886								5,771	2,886	2,886	2,886	2,886	2,886	2,886
	3	773711	947504	2	49	91	400		5,754	5,754								11,508	5,754	5,754	5,754	5,754	5,754	5,754
4	773969	947159	2	49	91	400																		
2	774045	948937	2	49	92	400		2,886	2,886	2,886							5,771	2,886	2,886	2,886	2,886	2,886	2,886	
5	773644	946478	2	50	91	400		5,754	5,754	5,754							11,508	5,754	5,754	5,754	5,754	5,754	5,754	
6	773926	946427	2	50	91	400																		
5001131	1	806010	927334	2	59	108	70	0,082	0,162	0,246	0,166	0,195	0,195	0,235	0,146	0,162	0,162	0,064	0,151	0,151	0,151	0,151	Blaney-Criddle	
	2	806304	928171	2	59	108	70	0,082	0,162	0,246	0,166	0,195	0,195	0,235	0,146	0,162	0,162	0,064	0,151	0,151	0,151	0,151	Blaney-Criddle	
5001169	1	802200	940390	2	53	106	100	0,306	0,493	0,731	0,473	0,577	0,577	0,622	0,699	0,439	0,55	0,364	0,457	0,457	0,457	0,457	Blaney-Criddle	
	2	802200	940400	2	53	106	100	0,306	0,493	0,731	0,473	0,577	0,577	0,622	0,699	0,439	0,55	0,364	0,457	0,457	0,457	0,457	Blaney-Criddle	
5001203	4	803603	937592	2	54	106	200	0,368	0,606	0,923	0,62	0,731	0,731	0,771	0,881	0,547	0,608	0,239	0,239	0,239	0,239	0,239	0,239	
1	804668	935398	2	55	107	200	0,368	0,606	0,923	0,62	0,731	0,731	0,771	0,881	0,547	0,608	0,239	0,239	0,239	0,239	0,239	0,239	0,239	
2	804423	936019	2	55	107	200	0,368	0,606	0,923	0,62	0,731	0,731	0,771	0,881	0,547	0,608	0,239	0,239	0,239	0,239	0,239	0,239	0,239	
5001203	3	804069	936794	2	55	107	200	0,368	0,606	0,923	0,62	0,731	0,731	0,771	0,881	0,547	0,608	0,239	0,239	0,239	0,239	0,239	0,239	0,239
5001204	1	802700	939300	2	53	106	60	0,249	0,49	0,747	0,502	0,591	0,591	0,623	0,713	0,442	0,492	0,193	0,458	0,458	0,458	0,458	Blaney-Criddle	
5001282	8	803253	936121	1	55	106	100	0,512	1,007	1,535	1,032	1,216	1,216	1,281	1,466	0,909	1,011	0,397	0,942	0,942	0,942	0,942	Blaney-Criddle	
6	803654	934110	1	56	106	100	0,512	1,007	1,535	1,032	1,216	1,216	1,281	1,466	0,909	1,011	0,397	0,942	0,942	0,942	0,942	Blaney-Criddle		
7	804398	934627	1	56	107	100	0,512	1,007	1,535	1,032	1,216	1,216	1,281	1,466	0,909	1,011	0,397	0,942	0,942	0,942	0,942	Blaney-Criddle		

TABLE E-4-A: Non-Potable Well Locations and Pumpages Used in Model
(Individual Water Use Permits) (Continued)

Permit No.	Well Name	State Plane Coord.		Csd	Pump Capacity	Feb	Mar	Apr	May	Jun	1990 Pumpage in Millions Gallons per Month						Source of Data			
		East	North								Jan	Feb	Mar	Apr	May	Jun	Jul	Aug		
5001282	2	803893	931351	1	57	106	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
	4	803954	932740	1	57	106	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
	9	803246	931250	1	57	106	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
	10	803511	931666	1	57	106	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
	3	804005	932904	1	57	107	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
	5	805515	932727	1	57	107	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
	1	803996	930914	1	58	106	100	0.512	1.007	1.535	1.032	1.216	1.281	1.466	0.909	1.011	0.397	0.942	0.884	
5001373	1	802674	933138	2	56	106	100	0.129	0.254	0.388	0.261	0.397	0.324	0.37	0.23	0.256	0.1	0.238	0.223	
	2	802679	934142	2	56	106	100	0.129	0.254	0.388	0.261	0.397	0.324	0.37	0.23	0.256	0.1	0.238	0.223	
	3	802654	935515	2	55	106	100	0.129	0.254	0.388	0.261	0.397	0.324	0.37	0.23	0.256	0.1	0.238	0.223	
5001391	1	801236	944650	2	51	105	100	0.071	0.14	0.213	0.143	0.169	0.178	0.203	0.126	0.14	0.065	0.131	0.123	
	2	800997	944651	2	51	105	100	0.071	0.14	0.213	0.143	0.169	0.178	0.203	0.126	0.14	0.065	0.131	0.123	
	3	800691	944433	2	51	105	100	0.071	0.14	0.213	0.143	0.169	0.178	0.203	0.126	0.14	0.065	0.131	0.123	
	4	800652	944157	2	51	105	100	0.071	0.14	0.213	0.143	0.169	0.178	0.203	0.126	0.14	0.065	0.131	0.123	
5001392	1	805186	931984	1	57	107	75	0.047	0.092	0.14	0.094	0.111	0.117	0.133	0.083	0.092	0.036	0.086	0.081	
	2	805208	931223	1	57	107	75	0.047	0.092	0.14	0.094	0.111	0.117	0.133	0.083	0.092	0.036	0.086	0.081	
	3	804748	931009	1	57	107	75	0.047	0.092	0.14	0.094	0.111	0.117	0.133	0.083	0.092	0.036	0.086	0.081	
	4	804622	931445	1	57	107	75	0.047	0.092	0.14	0.094	0.111	0.117	0.133	0.083	0.092	0.036	0.086	0.081	
5001484	1	806507	930964	1	58	108	45	0.186	0.365	0.557	0.374	0.441	0.465	0.531	0.33	0.367	0.144	0.341	0.321	
5001664	RINK	725712	934863	2	56	67	40	0.066	0.012	0.019	0.015	0.015	0.018	0.011	0.012	0.005	0.011	0.011	Pumpage Records	
5001842	1	792792	938812	2	54	101	135	0.213	0.419	0.638	0.429	0.505	0.533	0.609	0.378	0.42	0.165	0.391	0.368	Blaney-Criddle

**TABLE E-4-B: Non-Potable Well Locations and Pumpages Used in Model
(General Water Use Permits)**

Permit	State Plane Coord		Lay	Row	Col	Pump Capacity	Pumpage in Million Gallons per Month											
	East	North					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
79-54	755237	1040025	2	3	82	30	0.217	0.230	0.376	0.228	0.317	0.306	0.347	0.231	0.272	0.296	0.270	0.194
79-121	743250	1012320	2	17	76	90	0.348	0.368	0.601	0.365	0.507	0.490	0.555	0.369	0.436	0.474	0.432	0.310
79-194	743269	997350	2	24	76	200	0.378	0.407	0.697	0.431	0.590	0.543	0.628	0.422	0.440	0.436	0.505	0.353
79-194	743269	997350	2	24	76	200	0.378	0.407	0.697	0.431	0.590	0.543	0.628	0.422	0.440	0.436	0.505	0.353
81-222	760869	1015915	2	15	85	30	0.028	0.031	0.052	0.032	0.044	0.041	0.047	0.032	0.033	0.033	0.038	0.026
	760869	1015915	2	15	85	60	0.057	0.061	0.105	0.065	0.089	0.081	0.094	0.063	0.066	0.065	0.076	0.053
	760869	1015915	2	15	85	40	0.038	0.041	0.070	0.043	0.059	0.054	0.063	0.042	0.044	0.044	0.051	0.035
	760869	1015915	2	15	85	30	0.028	0.031	0.052	0.032	0.044	0.041	0.047	0.032	0.033	0.033	0.038	0.026
82-407	668168	1039164	2	3	39	25	0.076	0.081	0.139	0.086	0.118	0.109	0.126	0.084	0.088	0.087	0.101	0.071
83-118	697149	1031680	2	7	53	20	0.061	0.065	0.112	0.069	0.094	0.087	0.101	0.067	0.070	0.070	0.081	0.056
83-122	756355	1017148	2	14	83	267	1.423	1.532	2.621	1.620	2.219	2.042	2.362	1.586	1.654	1.640	1.899	1.327
84-153	771115	1014247	2	16	90	80	0.495	0.524	0.856	0.520	0.722	0.698	0.790	0.526	0.621	0.675	0.615	0.442
85-51	728342	1030450	2	8	69	20	0.115	0.124	0.212	0.131	0.180	0.166	0.192	0.129	0.134	0.133	0.154	0.108
	728342	1030450	2	8	69	400	2.307	2.483	4.249	2.627	3.598	3.311	3.830	2.572	2.682	2.660	3.079	2.152
85-76	781439	994273	2	26	95	25	0.008	0.008	0.014	0.009	0.012	0.011	0.013	0.008	0.009	0.009	0.010	0.007
85-107	781902	990126	2	28	95	200	0.608	0.644	1.052	0.639	0.887	0.857	0.971	0.646	0.763	0.829	0.755	0.542
85-192	726682	1032744	2	7	68	60	0.272	0.293	0.502	0.310	0.425	0.391	0.452	0.304	0.317	0.314	0.364	0.254
85-207	728914	1031584	2	7	69	60	0.149	0.160	0.274	0.169	0.232	0.214	0.247	0.166	0.173	0.172	0.199	0.139
85-361	761165	1024763	2	11	85	100	0.087	0.092	0.150	0.091	0.127	0.122	0.139	0.092	0.109	0.118	0.108	0.077
86-3	736044	1035422	2	5	73	120	0.227	0.244	0.418	0.259	0.354	0.326	0.377	0.253	0.264	0.262	0.303	0.212
86-20**	749937	985537	2	30	79	200	5.000	8.000	4.000	0.327	5.000	7.000	7.000				2.000	2.000
86-137	723650	1034500	2	6	66	130	0.288	0.310	0.530	0.237	0.449	0.413	0.477	0.321	0.334	0.332	0.384	0.268
86-148	748140	1033303	2	6	79	40	0.226	0.239	0.391	0.091	0.329	0.318	0.361	0.240	0.283	0.308	0.281	0.201
86-149	748395	1033248	2	6	79	40	0.087	0.092	0.150	0.137	0.127	0.122	0.139	0.092	0.109	0.118	0.108	0.077
86-171	748223	1032772	2	7	79	146	0.130	0.138	0.225	0.956	0.190	0.184	0.208	0.138	0.163	0.178	0.162	0.116
86-182	731035	1031711	2	7	70	130	0.840	0.904	1.547	0.274	1.310	1.206	1.395	0.936	0.977	0.969	1.121	0.784
86-266	748768	1032894	2	7	79	90	0.261	0.276	0.451	0.593	0.380	0.367	0.416	0.277	0.327	0.355	0.324	0.232
87-92	750746	1029171	2	8	80	150	0.565	0.598	0.977	0.301	0.824	0.795	0.901	0.600	0.708	0.770	0.701	0.504
87-110	779661	1000225	1	23	94	30	0.287	0.303	0.496	0.043	0.418	0.404	0.458	0.305	0.360	0.391	0.356	0.256
87-160	721195	1024450	2	11	65	20	0.038	0.041	0.070	0.172	0.059	0.054	0.063	0.042	0.044	0.044	0.051	0.035
87-392	762948	1015189	2	15	86	85	0.151	0.163	0.279	0.172	0.236	0.217	0.251	0.169	0.176	0.175	0.202	0.141
	762948	1015189	2	15	86	85	0.151	0.163	0.279	0.082	0.236	0.217	0.251	0.169	0.176	0.175	0.202	0.141
87-436	751465	1029891	2	8	80	80	0.078	0.083	0.135	0.023	0.114	0.110	0.125	0.083	0.098	0.107	0.097	0.070
88-27	746257	1027181	2	9	78	12	0.022	0.023	0.038	0.023	0.032	0.031	0.035	0.023	0.027	0.030	0.027	0.019
	746257	1027181	2	9	78	12	0.022	0.023	0.038	1.896	0.032	0.031	0.035	0.023	0.027	0.030	0.027	0.019
88-89	732484	1032026	2	7	71	200	1.665	1.792	3.067	1.137	2.597	2.390	2.764	1.856	1.936	1.920	2.222	1.553

**TABLE E-4-B: Non-Potable Well Locations and Pumpages Used in Model
(General Water Use Permits) (Continued)**

Permit	State Plane Coord		Lay	Row	Col	Pump Capacity	Pumpage in Million Gallons per Month											
	East	North					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
88-96	727339	1033266	2	6	68	200	0.999	1.075	1.840		1.558	1.434	1.658	1.114	1.161	1.152	1.333	0.932
88-153	722198	1018034	2	14	66	40	0.173	0.186	0.319	0.197	0.270	0.248	0.287	0.193	0.201	0.199	0.231	0.161
	722198	1018034	2	14	66	10	0.043	0.047	0.080	0.049	0.067	0.062	0.072	0.048	0.050	0.050	0.058	0.040
	722198	1018034	2	14	66	10	0.043	0.047	0.080	0.049	0.067	0.062	0.072	0.048	0.050	0.050	0.058	0.040
	722198	1018034	2	14	66	10	0.043	0.047	0.080	0.049	0.067	0.062	0.072	0.048	0.050	0.050	0.058	0.040
88-182	778394	998993	2	24	94	25	0.017	0.018	0.030	0.018	0.025	0.024	0.028	0.018	0.022	0.024	0.022	0.016
88-357	743772	1019869	2	13	76	12	0.151	0.163	0.279	0.172	0.236	0.217	0.251	0.169	0.176	0.175	0.202	0.141
43-00493	753066	1041018	2	2	81	160	0.000	0.000	0.000	0.073	0.101	0.098	0.111	0.074	0.087	0.095	0.086	0.062
43-00512	751991	1041298	2	2	80	140	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.028	0.033	0.036	0.032	0.023
79-106	780988	992076	2	27	95	25	0.062	0.100	0.148	0.096	0.117	0.126	0.141	0.089	0.111	0.074	0.092	0.086
85-186	788550	959700	2	43	99	45	0.371	0.597	0.886	0.574	0.699	0.754	0.847	0.532	0.667	0.441	0.554	0.517
86-331	795151	967233	1	39	102	20	0.087	0.139	0.207	0.134	0.163	0.176	0.198	0.124	0.156	0.103	0.129	0.121
87-82	794422	969117	2	38	102	50	0.056	0.090	0.133	0.086	0.105	0.113	0.127	0.080	0.100	0.066	0.083	0.078
43-00528	788082	961483	1	42	99	20	0.031	0.050	0.074	0.048	0.058	0.063	0.071	0.044	0.056	0.037	0.046	0.043
	788082	961483	1	42	99	20	0.031	0.050	0.074	0.048	0.058	0.063	0.071	0.044	0.056	0.037	0.046	0.043
82-398	763019	938958	2	54	86	15	0.009	0.018	0.027	0.018	0.022	0.023	0.026	0.016	0.018	0.007	0.017	0.016
	763019	938958	2	54	86	60	0.036	0.071	0.109	0.073	0.086	0.091	0.104	0.064	0.072	0.028	0.067	0.063
84-123	791569	941889	2	52	100	40	0.063	0.125	0.190	0.128	0.151	0.159	0.181	0.113	0.125	0.049	0.117	0.109
	791569	941889	2	52	100	40	0.063	0.125	0.190	0.128	0.151	0.159	0.181	0.113	0.125	0.049	0.117	0.109
84-212	806933	928293	1	59	108	25	0.034	0.067	0.102	0.068	0.081	0.085	0.097	0.060	0.067	0.026	0.062	0.059
	806933	928293	1	59	108	25	0.034	0.067	0.102	0.068	0.081	0.085	0.097	0.060	0.067	0.026	0.062	0.059
84-224	726123	934573	2	56	68	200	0.059	0.116	0.177	0.119	0.140	0.147	0.169	0.104	0.116	0.046	0.108	0.102
85-48	806358	932778	2	57	108	50	0.310	0.498	0.739	0.478	0.583	0.628	0.706	0.444	0.556	0.367	0.462	0.431
85-301	799236	946180	2	50	104	45	0.014	0.027	0.041	0.027	0.032	0.034	0.039	0.024	0.027	0.011	0.025	0.023
85-352	783178	944935	2	51	96	150	0.665	1.309	1.996	1.341	1.581	1.666	1.905	1.182	1.315	0.516	1.224	1.150
85-353	783185	944010	2	51	96	150	0.815	1.603	2.444	1.642	1.936	2.040	2.333	1.447	1.610	0.632	1.499	1.408
85-376	778562	942314	2	52	94	75	0.102	0.200	0.305	0.205	0.242	0.255	0.292	0.181	0.201	0.079	0.187	0.176
	777748	942342	2	52	93	75	0.102	0.200	0.305	0.205	0.242	0.255	0.292	0.181	0.201	0.079	0.187	0.176
86-23	805866	932125	2	57	107	60	0.038	0.074	0.113	0.076	0.090	0.094	0.108	0.067	0.075	0.029	0.069	0.065
	805866	932125	2	57	107	60	0.038	0.074	0.113	0.076	0.090	0.094	0.108	0.067	0.075	0.029	0.069	0.065
	805866	932125	2	57	107	60	0.038	0.074	0.113	0.076	0.090	0.094	0.108	0.067	0.075	0.029	0.069	0.065
86-84	780931	946224	2	50	95	120	0.068	0.134	0.204	0.137	0.161	0.170	0.194	0.121	0.134	0.053	0.125	0.117
	780931	946224	2	50	95	120	0.068	0.134	0.204	0.137	0.161	0.170	0.194	0.121	0.134	0.053	0.125	0.117
86-200	784704	942980	2	52	97	90	0.136	0.267	0.407	0.274	0.323	0.340	0.389	0.241	0.268	0.105	0.250	0.235
87-450	767585	946953	2	50	88	65	0.005	0.009	0.014	0.009	0.011	0.011	0.013	0.008	0.009	0.004	0.008	0.008
88-261	781180	945874	2	50	95	80	0.077	0.151	0.231	0.155	0.183	0.193	0.220	0.137	0.152	0.060	0.142	0.133
88-441	781342	949225	2	48	95	150	0.407	0.802	1.222	0.821	0.968	1.020	1.167	0.723	0.805	0.316	0.749	0.704
50-01797	725769	938580	2	54	67	15	0.005	0.009	0.014	0.009	0.011	0.011	0.013	0.008	0.009	0.004	0.008	0.008

**TABLE E-4-B: Non-Potable Well Locations and Pumpages Used in Model
(General Water Use Permits) (Continued)**

Permit	State Plane Coord		Lay	Row	Col	Pump Capacity	Pumpage in Million Gallons per Month												
	East	North					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
50-01896	782825	958718	2	44	96	60	0.000	0.000	0.000	0.000	0.525	0.565	0.635	0.399	0.500	0.331	0.415	0.388	
50-01961	780218	943574	2	51	95	55	0.000	0.000	0.000	0.000	0.000	0.000	0.648	0.402	0.447	0.176	0.416	0.391	
50-02016	784270	943582	2	51	97	45	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.179	0.070	0.167	0.156	
88-133 [*]	757854	947268	2	49	83	15	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	
88-134 [*]	755577	943698	2	51	82	15	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	
79-104 [*]	745632	1036225	2	55	72	20	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	
82-60 [*]	719201	1026696	2	10	59	25	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	
82-161 [*]	744859	1013079	2	16	77		0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	
82-233 [*]	748495	1018876	2	14	79	250	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	
82-242 [*]	726652	1024515	2	11	68	84	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	
87-253 [*]	776080	983310	2	31	93	200	1.275	1.275	1.275	1.275	1.275	1.275	1.275	1.275	1.275	1.275	1.275	1.275	
87-258 [*]	642073	1023092	2	11	26	200	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	
87-361 [*]	658456	1000252	2	23	34	30	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	
87-432 [*]	745278	1028694	2	9	77	150	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	
82-354 [*]	745184	1023982	2	11	77	200	0.135	0.135	0.405	0.405	0.405	0.405	0.405	0.405	0.405	0.405	0.135	0.135	0.135
87-176 [*]	711290	1031831	2	7	60	400	0.600	0.600	0.600	0.600	0.600	0.600	0.600			0.600	0.600	0.600	0.600
87-448 [*]	717178	1027984	2	9	63	30	0.075	0.075	0.075	0.075	0.075						0.075	0.075	
88-277 [*]	751270	959680	2	43	80	100	1.200	1.200	1.200	1.200	1.200						1.200	1.200	
Block 28A ^{**}	651000	980400	2	33	30		0.569	0.814	0.209	0.284	0.913	0.529	0.221	0.112	0.010	0.062	0.432	0.473	
Block 32 ^{**}	649200	977900	2	34	29		1.883	2.016	0.784	1.715	1.722	0.294	0.538	0.639	0.140	0.063	1.785	1.162	
Block 32 ^{**}	649200	979100	2	33	29		0.792	0.864	0.510	0.828	0.294	0.060	0.439	0.145		0.099	0.297	0.228	
Block 33 ^{**}	651050	978500	2	34	30		2.086	1.836	1.083	1.722	3.108	1.980	0.456	0.343	0.017	0.228	1.773	1.817	

Unless otherwise noted, all pumpages were calculated using the Blaney-Criddle Formula.

* = Nursery Permit: Pumpage calculated by multiplying the "Average Day" Water Use Permit Allocation by 15 days per month.

** = Actual reported pumpage used (Groves)

TABLE E-5: Non-Potable Water Use Permits in Model Area and Comparison of Modelled to Permitted Pumpage

Permit Number	Use Type	Owner	Model Q (mgy)	Permitted (mgy)	% Diff Model/Permit
4300013	GLF	KING MOUNTAIN CONDO	-0.036	11.10	0
4300017	AG	MONTEREY FLOWERS INC.	-3.103	13.80	22
4300021	AG	SOUTH FLORIDA GRASSING	-291.243	288.90	101
4300031	GLF	MARTIN CO. GOLF & C.C.	-147.919	229.90	64
4300032	GLF	YACHT & COUNTRY CLUB, INC.	-183.803	176.80	104
4300064	GLF	MARINER SANDS COUNTRY CLUB	-406.955	271.20	150
4300069	RECR	MID RIVERS INC.	-50.410	119.00	42
4300132	AG	S & S FLOWER FARMS	-5.161	4.30	120
4300156	LSC	MARTIN CO. SCHOOL BOARD	-16.521	37.90	44
4300198	GLF	PIPER'S LANDING	-67.390	83.80	80
4300261	LSC	RGA DEV. (CUTTER SOUND)	-59.462	61.90	96
4300266	GLF	ENVIRON. VENTURES (THE WATERFORD)	-38.871	361.40	11
4300335	AG	J. & J. DAVIS (TARHEAL FARMS)	-41.687	67.40	62
4300368	AG	PALM CITY SOD	-482.064	333.00	145
4300382	LSC	LOBLOLLY PINES DEVELOPMENT	-20.481	98.40	21
4300425	LSC	J. RICHARD HARRIS (CAPTAIN'S CREEK)	-8.161	7.90	103
4300434	GOL	CORNERSTONE GROUP (COBBLESTONE C.C.)	-25.595	113.30	23
4300441	LAN	MARINER SANDS PROP. OWNERS	-34.103	69.40	49
4300502	LSC	MARTIN CO. (HOLT LAW ENF. CENTER)	-21.007	19.70	107
4300054	GLF	JUPITER HILLS CLUB	-421.972	160.60	263
4300091	GLF	RIVER BEND GOLF COURSE	-100.428		
4300138	GLF	LINKS GROUP (CYPRESS LINKS GOLF COURSE)	-27.592	134.90	20
4300200	AG	JOHN D. & NANCY P. MARTIN (LESSEE)	-809.826	295.00	275
4300202	LSC	LITTLE CLUB CONDO ASSOC.	-3.358	24.30	14
4300273	GLF	HOBE SOUND WATER COMPANY	-127.696	51.10	250
4300371	GLF	HOBE SOUND GOLF CLUB	-35.358	133.90	26
4300375	AG	PERO FAMILY FARMS	-165.058	456.00	36
5000153	AG	RESTIGOUCHE, INC (MAPLEWOOD)	-49.198	80.77	61
5000223	GLF	TEQUESTA COUNTRY CLUB	-10.427		
5000237	AG	JONATHAN'S LANDING	-63.602	318.90	20
5000344	AG	S & J FARMS	-1204.780	78.20	1541
5000547	AG	AMERICAN FOODS	-275.769	92.40	298
5001131	LAN	SEA OATS OF JUNO BEACH	-3.914	13.80	28
5001169	LAN	JUPITER 1 HOMEOWNERS	-12.272	3.23	380
5001203	LAN	RADNOR CORPORATION	-29.321	30.30	97
5001204	LAN	OCEANSIDE TERRACE HOMEOWNERS	-5.929	2.00	296
5001282	LAN	THE RIDGE AT THE BLUFFS	-121.896	51.60	236
5001373	LAN	THE RIVER HOMEOWNERS	-9.240	21.65	43
5001391	LAN	JUPITER BAY HOMEOWNERS	-6.766	8.37	81
5001392	LAN	LJ JUPITER VENTURE (VILLAS OF OCEAN DUNES)	-4.448	8.37	53
5001484	LAN	JUPITER BEACHCOMBER CONDO	-4.421	1.35	327
5001664	LAN	PRATT & WHITNEY	-0.147	37.89	0
5001842	LAN	MARQUETTE ELECTRONICS	-5.067	5.13	99
4300009	AG	SUNSHINE STATE CARNATION	-9.751	6.10	160
4300022	IND	FLORIDA POWER & LIGHT	-243.099	300.00	81
4300051	NUR	R. M. RINKER FARMS INC.	-6.048	18.10	33
4300055	COMM	ROBERTS FISH FARM	-30.776	30.80	100
4300059	COMM	LARRY WRIGHT'S FISH FARM	-36.498	36.50	100
4300057	AG	HOBE-ST. LUCIE CONSERVANCY	-2743.668	4460.00	62
4300107	NUR	HOWE HOLDINGS INC. (FERNLEA NURSERIES)	-9.406	20.40	46
4300143	NUR	STUART FARMS	-22.613	41.30	55
4300144	NUR	SCHRAMM'S FLOWERS	-7.936	8.50	93
4300182	NUR	RICHARD G. & MARSHA HUPFEL	-2.700	8.00	34
4300206	AG	BLOOD'S HAMMOCK GROVES, INC	-17.862	18.40	97
4300242	NUR	MARTIN CO. TREE GROWERS	-6.908	48.00	14
4300251	NUR	LOXAHATCHEE NURSERY OF STUART	-25.938	38.20	68
4300399	NUR	O. & E. NISSEN (SUSHINE STATE CARNATION)	-7.199	34.00	21
4300409	NUR	R. REMELIUS (CLASSIC GROWERS)	-22.676	49.30	46
Rodriguez	AG	No Permit	-204.075		
Necca	AG	No Permit	-1117.341		
4300362	IND	CAULKINS INDIANTOWN CITRUS CO.	-0.283	50.00	1
General Permits					
7900054	LSC	KINGSWOOD, INC.	-3.282	3.65	90
7900121	PWSI	STEFFENS TOWNSHOUSE	-5.252	36.50	14
7900194	PWSI	MARTIN CO. (SOUTH FORK H.S.)	-11.660	36.50	32
8100222	PWSI	R.C. LINDSEY (VISTA SALERNO SUBD.)	-2.332	3.65	64
8200407	PWSI	MARTIN CO. STOCKADE	-1.166	36.50	3
8300118	LAN	INDIANTOWN TELEPHONE CO.	-0.933	36.50	3
8300122	LAN	MONTEGO COVE	-21.920	32.10	68

TABLE E-5: Non-Potable Water Use Permits in Model Area and Comparison of Modelled to Permitted Pumpage (Continued)

8400153	SEABRIDGE ASS. (BUNKER HILL @ HRTGE RDGE)	-7.484	36.50	21
8500051 LAN	MARTIN DOWNS (SUNSET TRACE)	-37.320	31.30	119
8500076 LAN	GTE SPRINT COMMUN. (R-2 REPEATER)	-0.117	36.50	0
8500107 LAN	MARTIN CO. (J.V. REED PARK)	-9.190	27.30	34
8500192 LAN	STARLING COURT (MARTIN DOWNS)	-4.197	6.23	67
8500207 LAN	R.H. PROPERTIES (VILLAGE CENTER)	-2.293	10.20	22
8500361 LAN	PIRATES COVE	-1.313	2.00	66
8600003 LAN	MARTIN DOWNS PUBLIC PARKS	-3.498	5.18	68
8600020 AG	KIM POY LEE & SONS	-43.431	32.80	132
8600137 IRR	MALLARD CREEK	-4.430	8.85	50
8600148 LAN	KINGMAN ACRES CONDO	-3.414	3.61	95
8600149 LAN	KINGMAN ACRES CLUB	-1.313	0.73	180
8600171 LAN	KINGMAN ACRES VILLAGE IIA	-1.970	2.81	70
8600182 LAN	MONARCH POINT DEV. (PARCEL 35)	-12.942	25.50	51
8600266 LAN	REGENCY SQUARE	-3.938	23.60	17
8700092 LAN	SHOPS OF STUART/WEDGEWOOD COMMONS	-8.534	11.40	75
8700110 LAN	WHIPPOORWILL SUBDIVISION	-4.332	7.53	58
8700160 PWSI	EPISCOPAL CHURCH OF THE ADVENT	-0.583	0.33	178
8700392 LAN	FAIRWAY GARDENS	-4.664	1.64	284
8700436 LAN	INDIAN STREET SHOPPES	-1.182	8.76	13
8800027 PWSI	WATERFORD ADMIN. & SALES CTR.	-0.656	1.99	33
8800089 LAN	CHARTER CLUB AT MARTIN DOWNS	-25.651	32.80	78
8800096 LAN	IBIS POINT AT MARTIN DOWNS	-15.391	30.50	50
8800153 LAN	PENNWOOD FARM	-4.665	0.73	639
8800182 PWSI	JERRY'S FOUR SEASONS MARKET	-0.263	0.37	72
8800357 LAN	MY SCHOOL LEARNING CTR	-2.332	2.92	80
4300493 LAN	MARTIN CO. ADMIN. COMPLEX	-0.787	1.97	40
4300512 LAN	FIRST NATIONAL BANK (SE OCEAN BLVD)	-0.193	0.66	29
7900106 PWS	GOLDEN CORRAL STEAK HOUSE	-1.240	3.65	34
8500186 IRR	TURTLE CREEK EAST	-7.439	21.90	34
8600331 LAN	INDIAN HILLS	-1.735	3.13	55
8700082 LAN	JUPITER-TEQ. CHURCH OF CHRIST	-1.116	2.04	55
4300528 LAN	TURTLE CREEK CLUB	-1.241	2.31	54
8200398 PWIR	W. T. BELLEW	-1.078		
8400123 AG	SUMMER WINDS OF JUPITER	-3.018	3.28	92
8400212 AG	LOGGERHEAD PLAZA	-1.617	2.55	63
8400224 AG	PRATT & WHITNEY	-1.401	7.11	20
8500048 AG	OCEAN @ THE BLUFFS SOUTH	-6.199	3.50	177
8500301 AG	BANANA MAX	-0.323	2.19	15
8500352 AG	CHASEWOOD NORTH	-15.846	27.30	58
8500353 AG	CHASEWOOD OF JUPITER	-19.403	32.80	59
8500376 AG	JUPITER PK OF COMMERCE	-4.851	19.10	25
8600023 AG	BLUFFS SQUARE SHOPPES	-2.694		
8600084 AG	JUPITER HEALTH & RECRE. CENTER	-3.234	3.65	89
8600200 AG	MAPLEWOOD PARK, PHASE I	-3.233	8.39	39
8700450 PWSI	SIERRA SQUARE	-0.108	0.44	25
8800261 AG	JUPITER WEST	-1.833	7.30	25
8800441 AG	ELEMENTARY SCHOOL "A" (LIMESTONE CRK)	-9.702	19.40	50
5001797 PWSI	H & B TOOL	-0.108	0.37	30
5001896 AG	LOXAHATCHEE POINTE	-3.758	7.30	51
5001961 AG	MALLARDS COVE II	-2.479	5.91	42
5002016 AG	LAUREL OAKS	-0.572	2.19	26
8800133 NUR	PARAMOUNT NURSERY (NORTH SITE)	-14.396	21.90	66
8800134 NUR	PARAMOUNT NURSERY (SOUTH SITE)	-14.396	21.90	66
7900104 PWS	F. PASQUALINO (RESTAURANT)	-0.719	3.65	20
8200060 NUR	ADAMS NURSERY	-3.239	36.50	9
8200161 NUR	BIG PINE NURSERY	-1.080	36.50	3
8200233 NUR	ELIAS LUSTIG	-1.799	36.50	5
8200242 NUR	PINDER'S NURSERY	-0.899	2.92	31
8700253 NUR	BUILD INC.	-15.298	32.80	47
8700258 AG	TURNPike DAIRY	-21.884	32.80	67
8700361 NUR	ISLAND PLANT NURSERIES	-7.198	21.90	33
8700432 NUR	BURKEY NURSERY	-3.600	3.65	99
8200354 NUR	D. KOUBA (THE PLANT FACTORY)	-3.508	36.50	10
8700176 NUR	D. GLUCKLER (FLOWER FARM)	-5.998	35.00	17
8700448 NUR	WATER-RITE TREE FARM	-0.525	7.30	7
8800277 NUR	JUPITER TREE FARM	-8.398	32.80	26
Block28 AG	Unpermitted	-4.627		
Block32S AG	Unpermitted	-12.738		
Block32N AG	Unpermitted	-4.555		
Block33 AG	Unpermitted	-16.445		

Key to Use Types:

AG = Agricultural
IND = Industrial

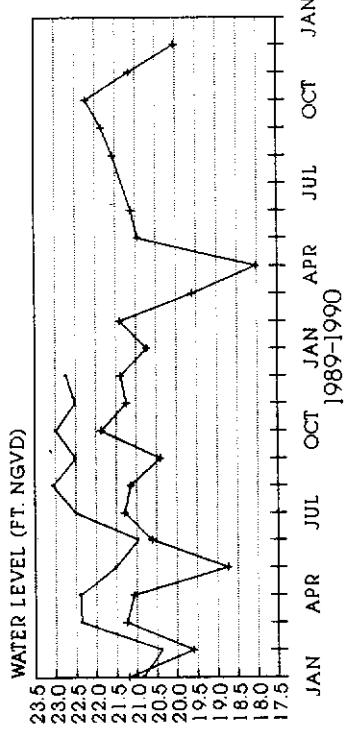
GLF = Golf
COMM = Commercial

NUR = Nursery
LAN,LSC,IRR = Landscape
PWSI = Public Water Supply & Irrigation

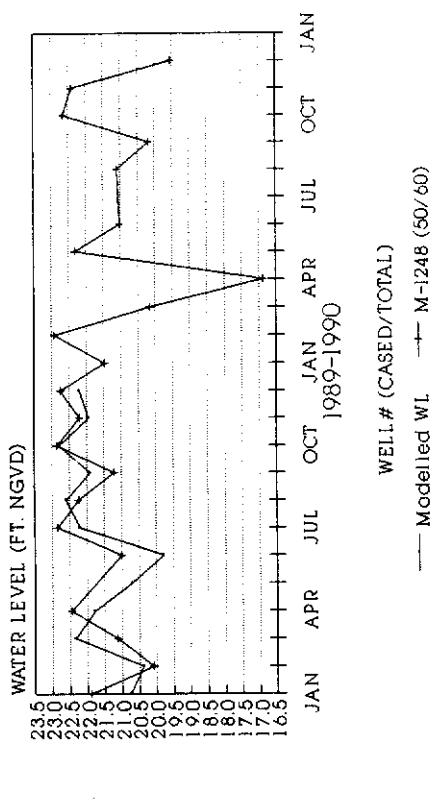
APPENDIX F

COMPUTED AND OBSERVED
HYDROGRAPHS REPRESENTING
MONITOR WELLS, 1989

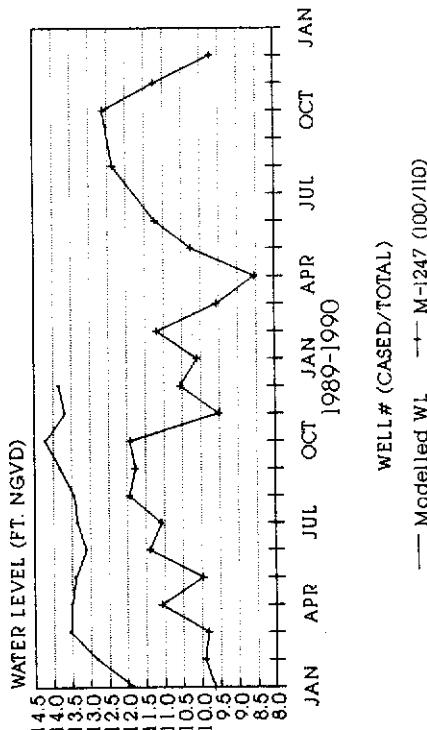
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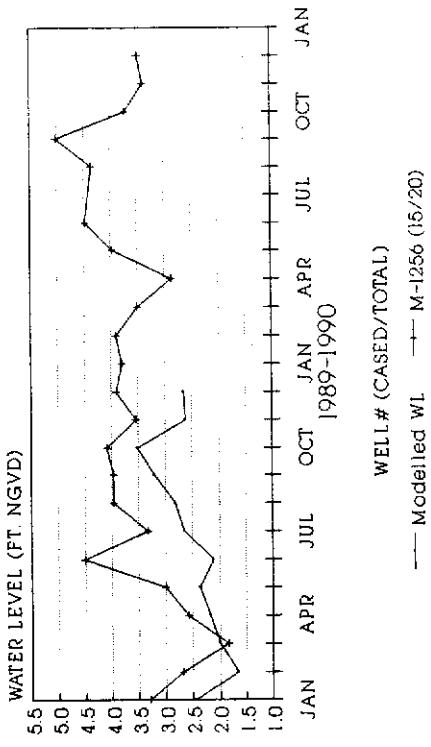
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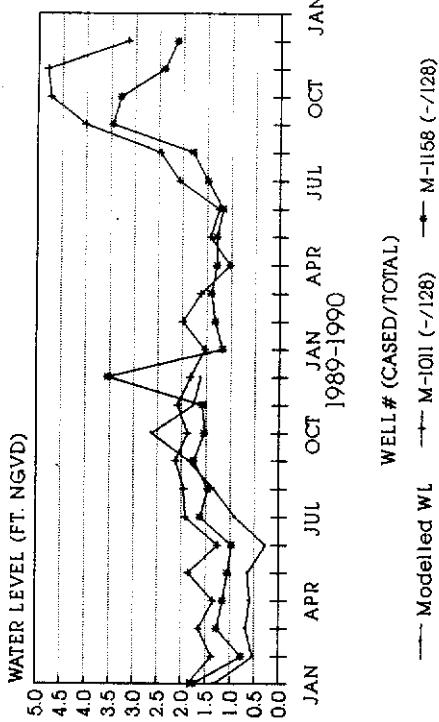


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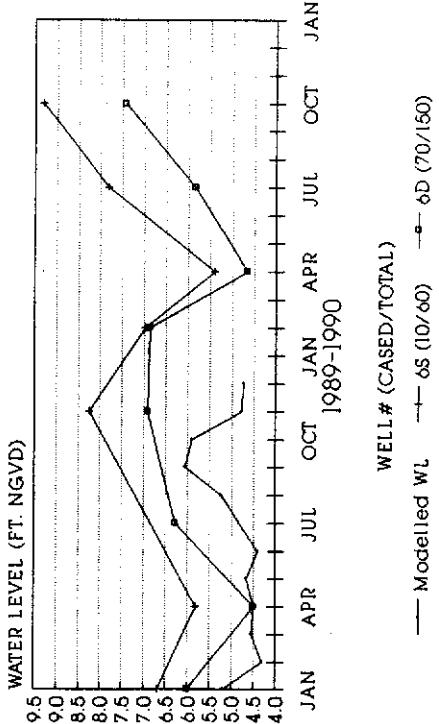
SIT. M.D.

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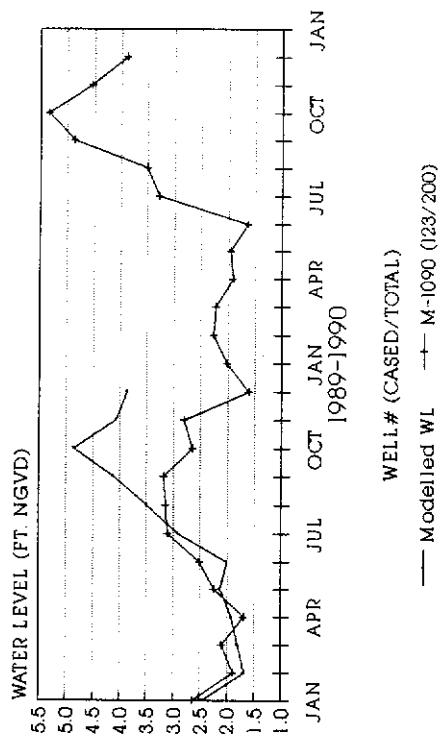
Stuart

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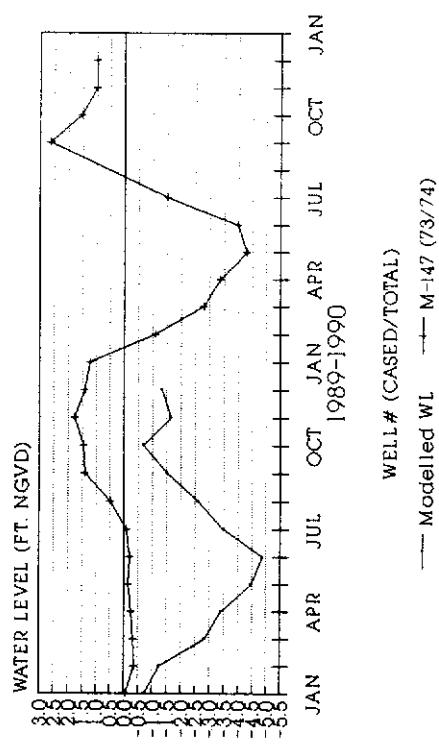
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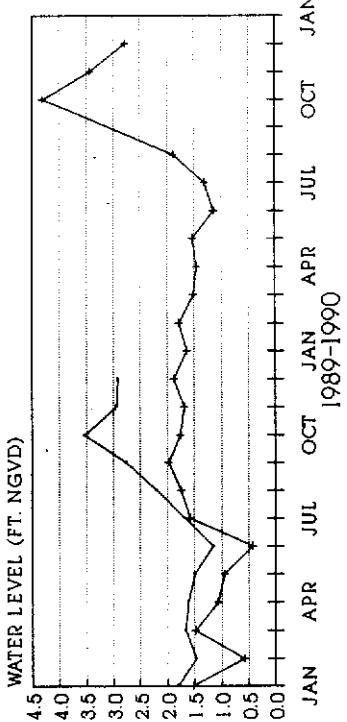
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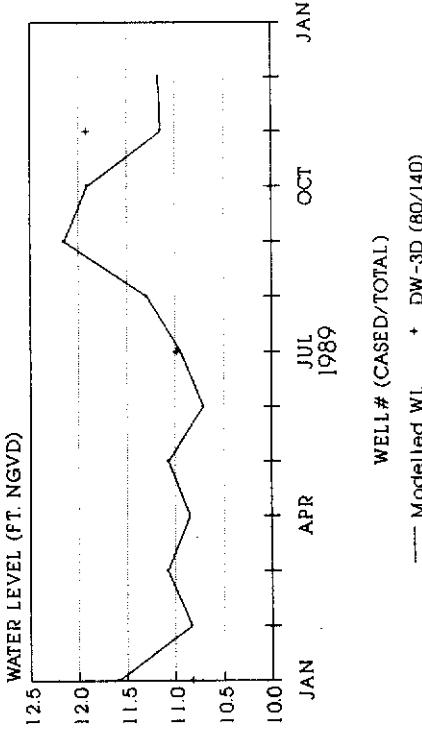
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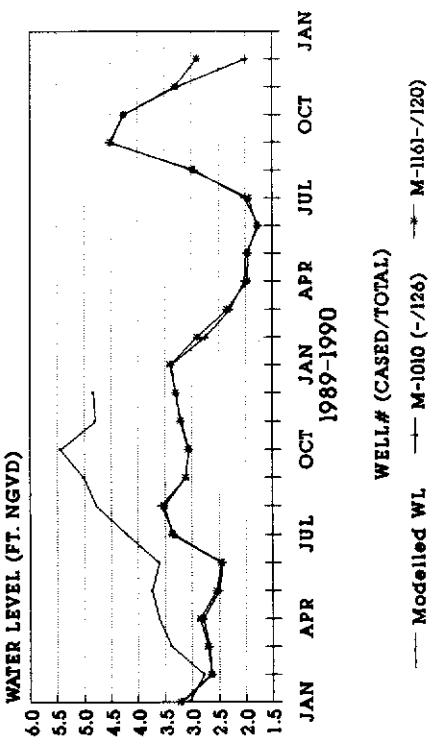
Stuart

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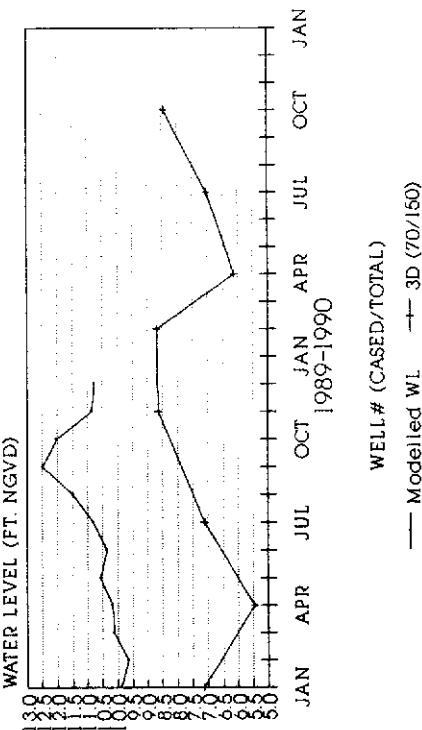
Martin Downs

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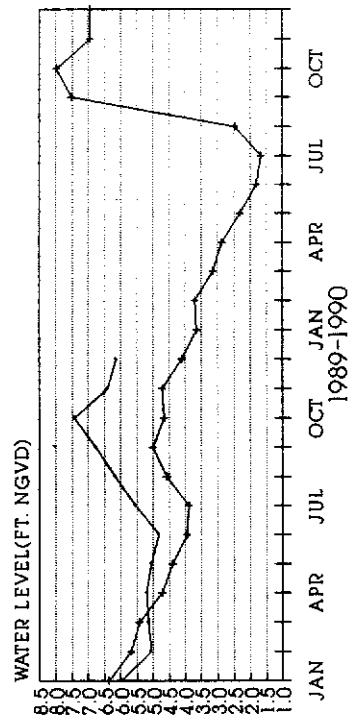
Student

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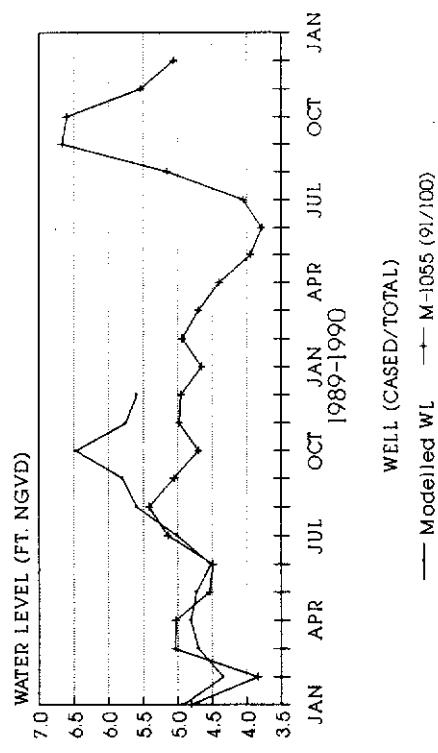


Marlin Downie

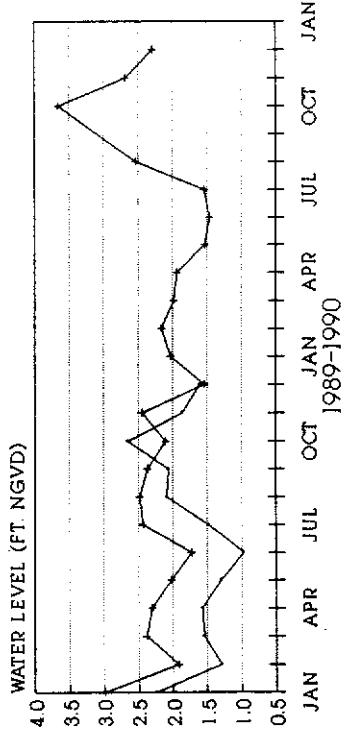
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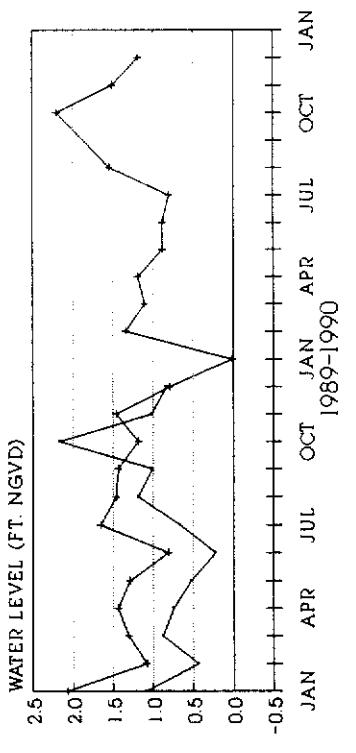
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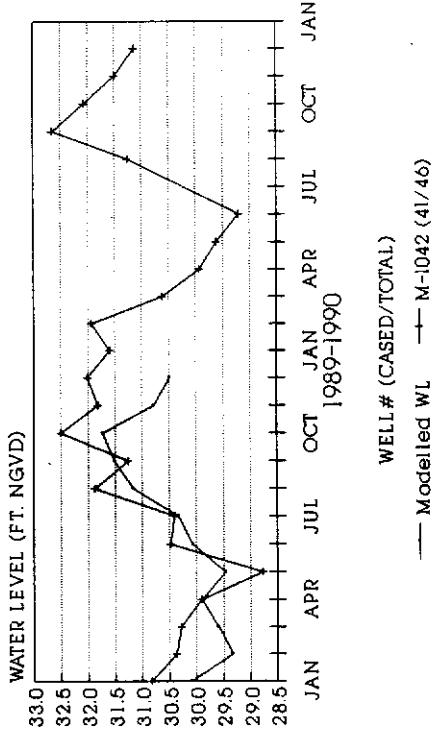
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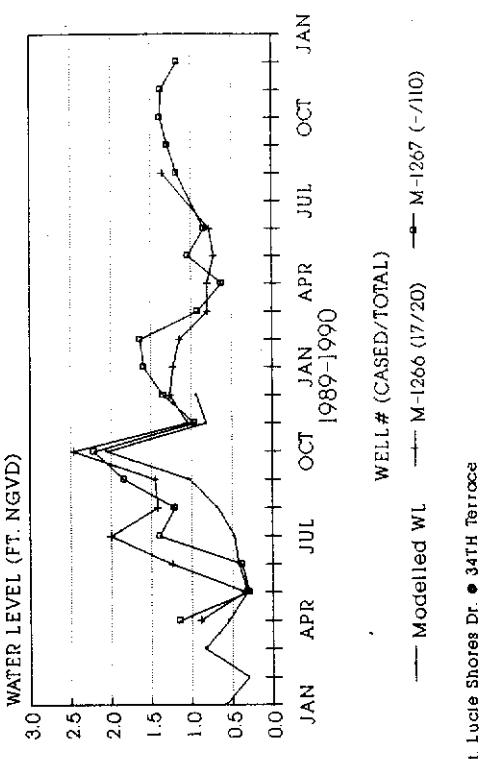
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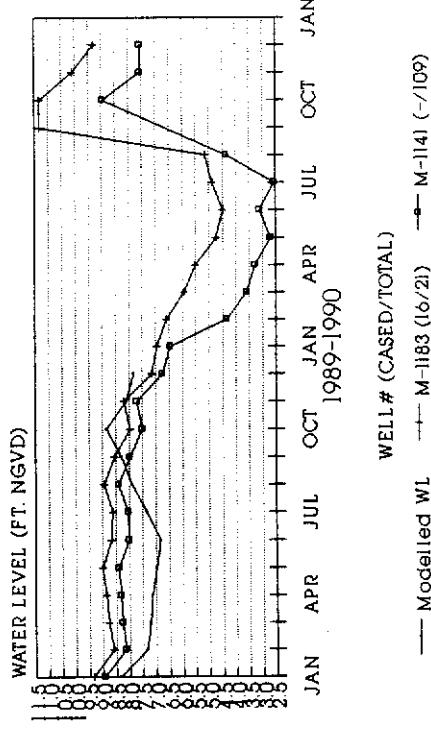
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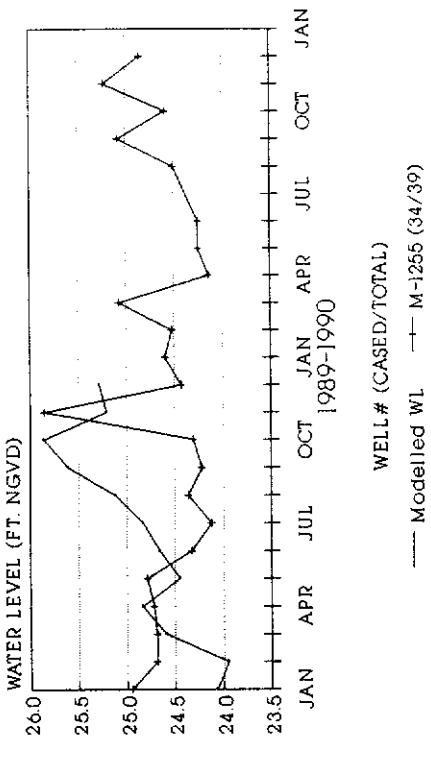
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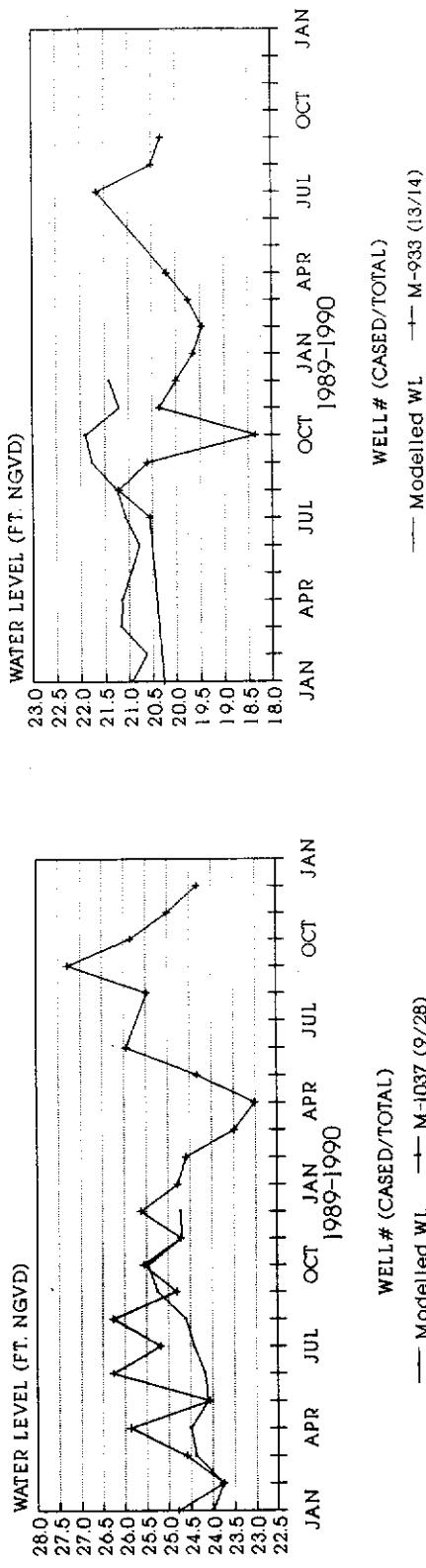
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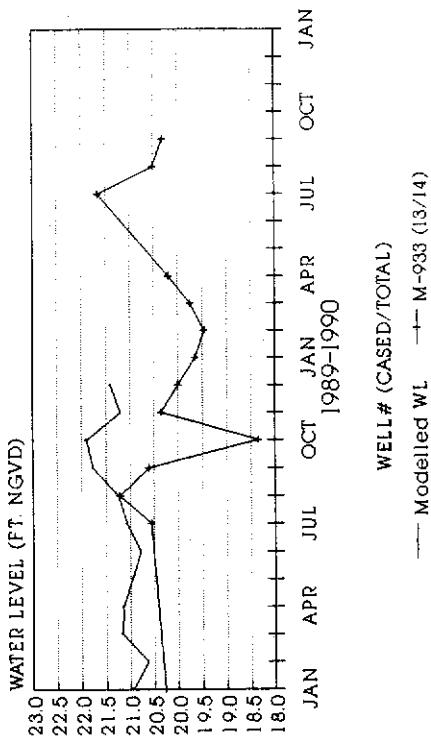
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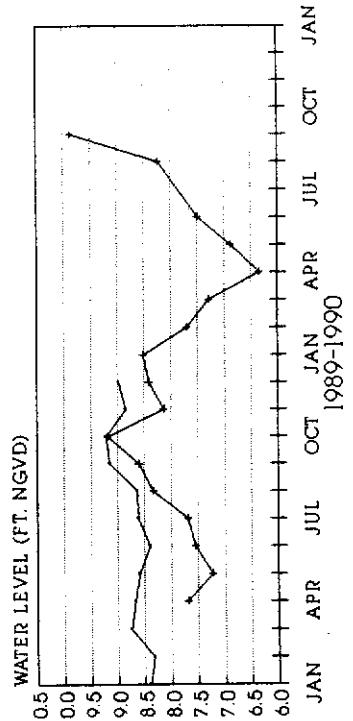
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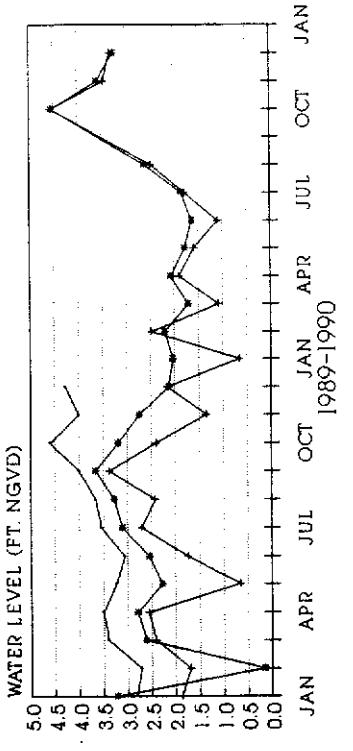
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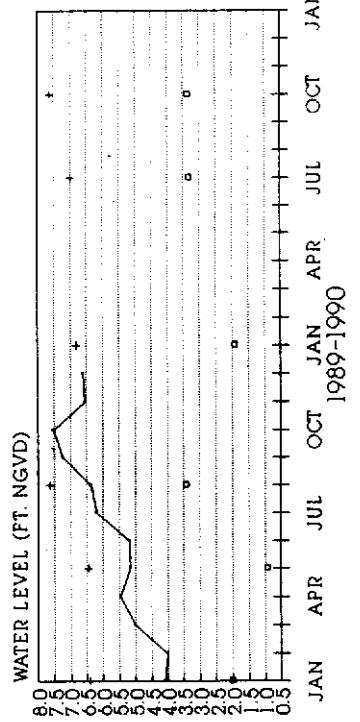
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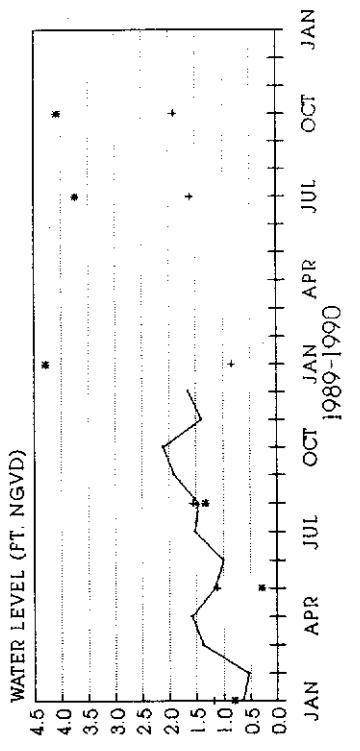
Stuart

SR714 • Donforth Creek

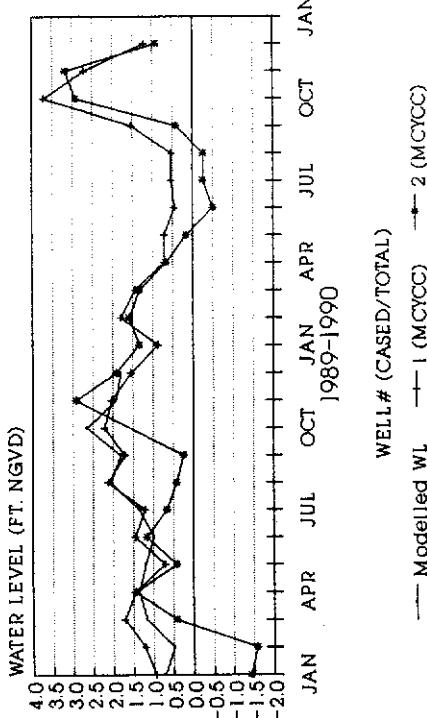
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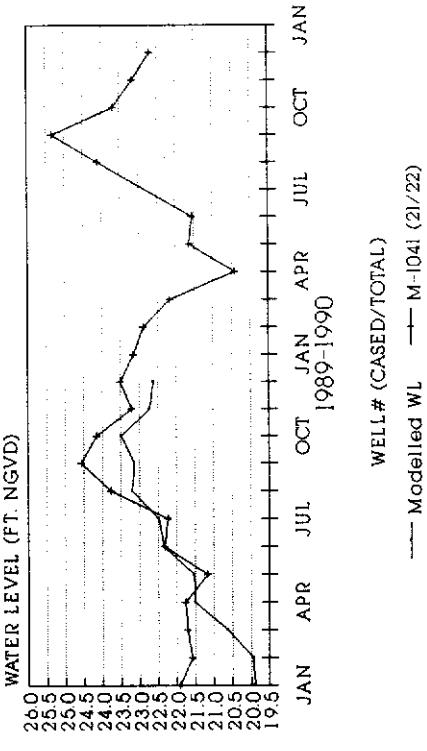
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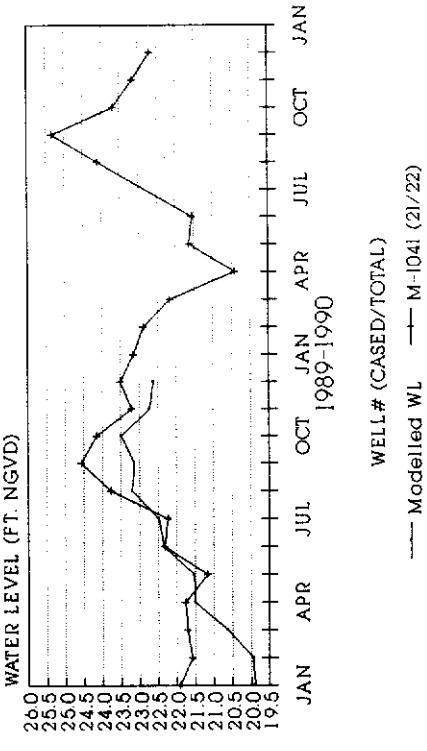
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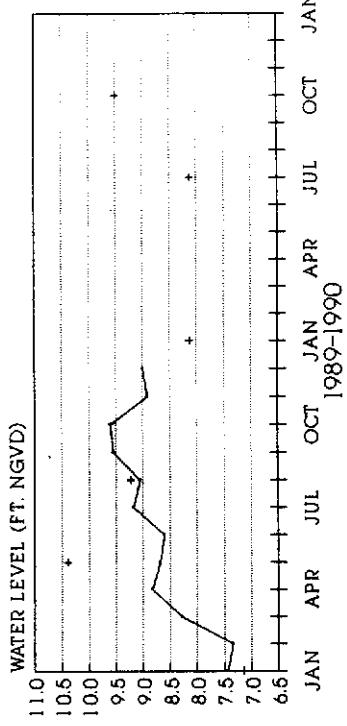
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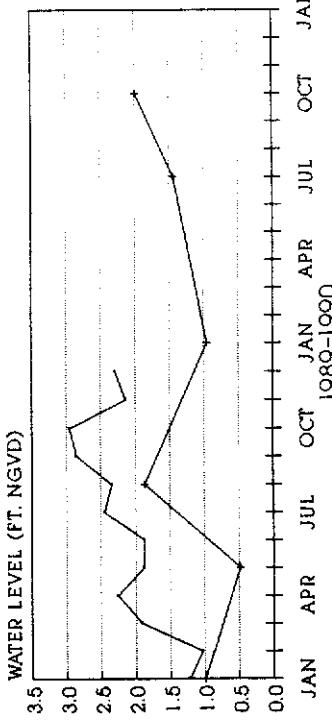
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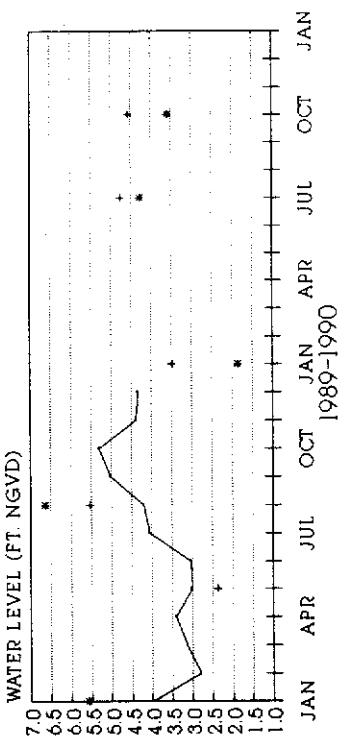
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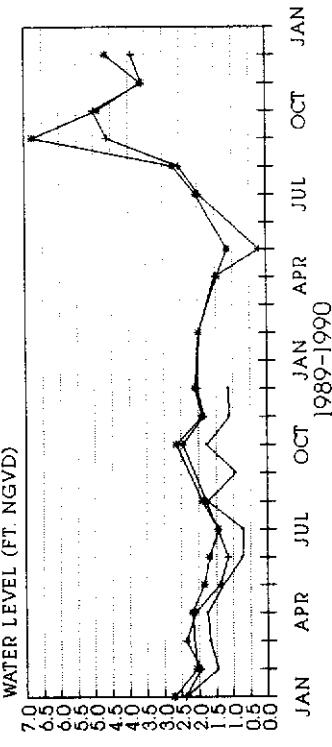
Piper's Landing

Pipers Landing

ROW II, COLUMN 73



ROW 11, COLUMN 87



Miss Grant

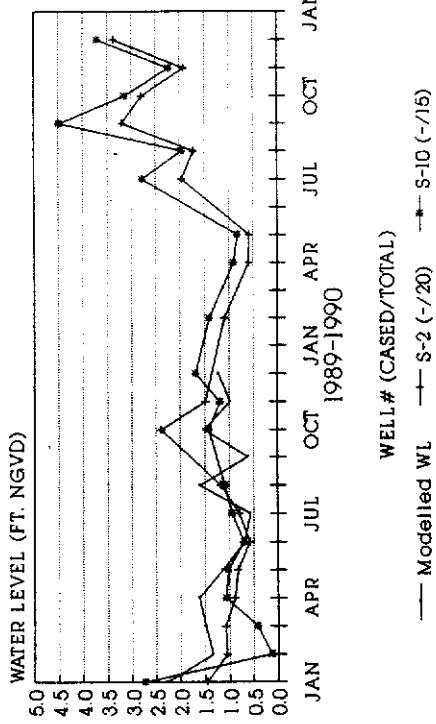
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M. M. Pelešov

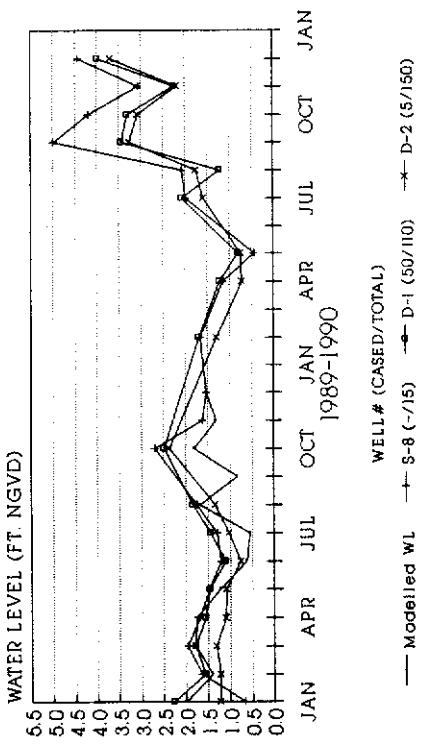
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198

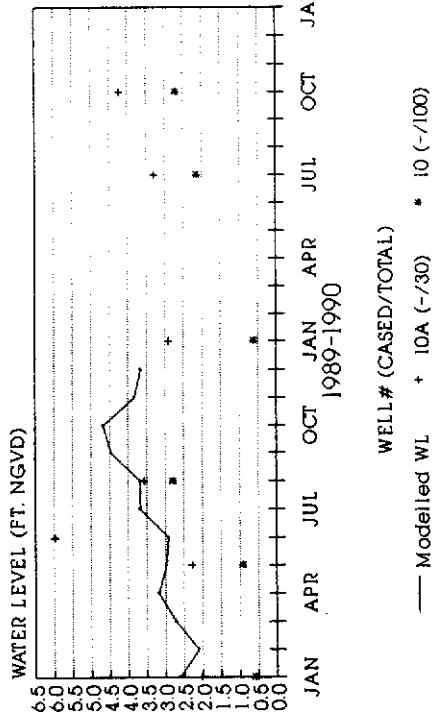
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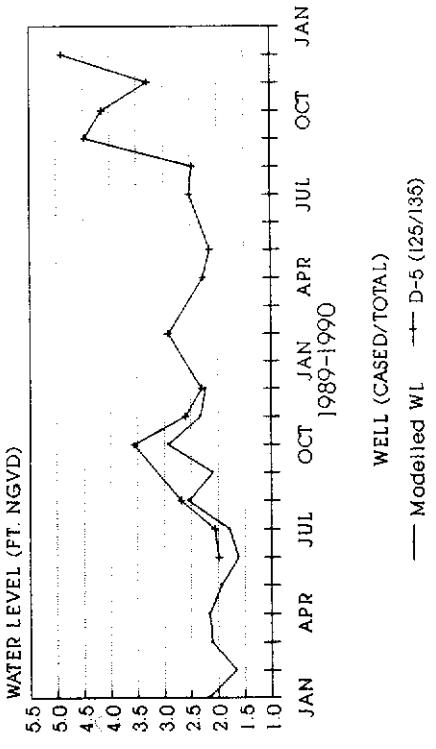
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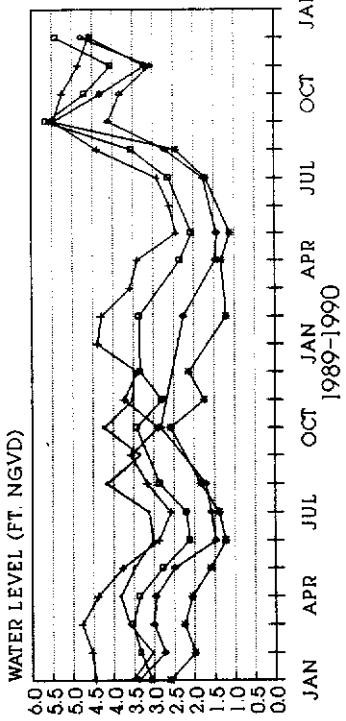
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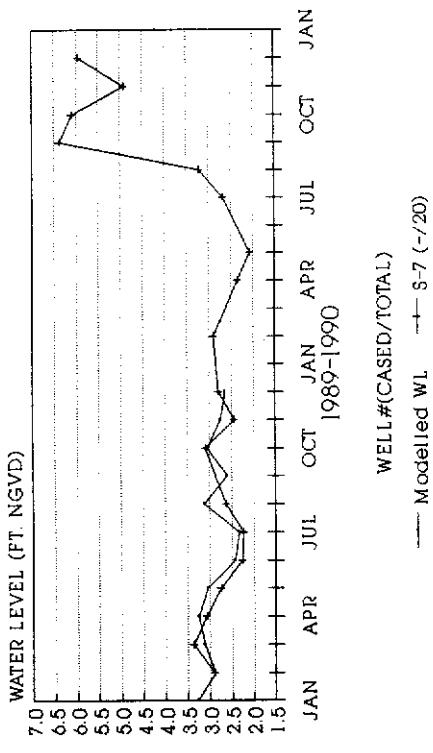
ROW 12, COLUMN 86



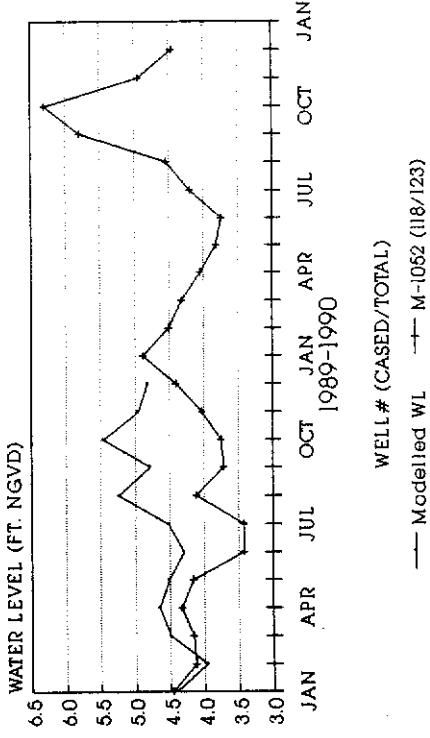
ROW 12, COLUMN 87



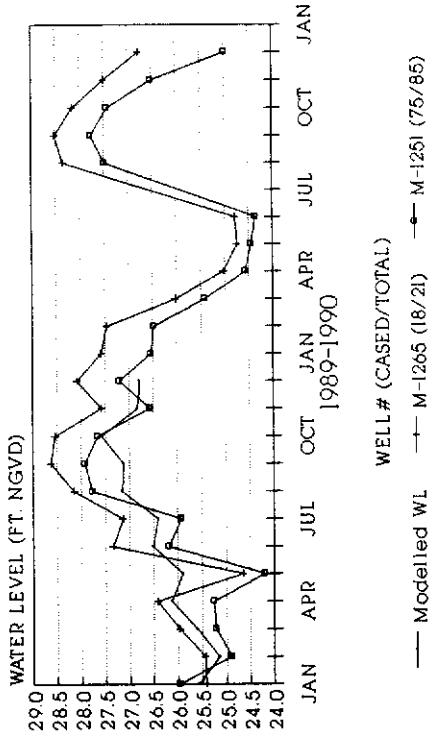
ROW 12, COLUMN 88



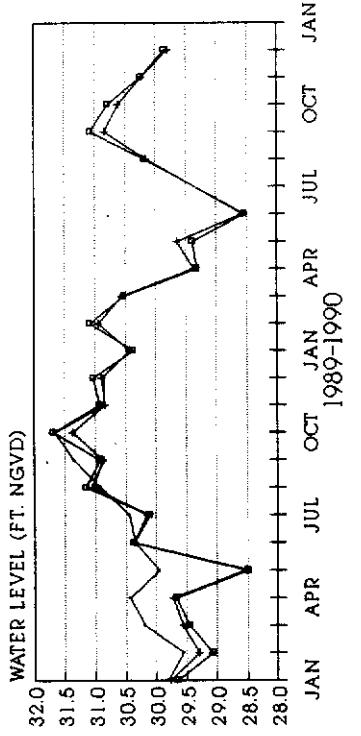
ROW 13, COLUMN 86



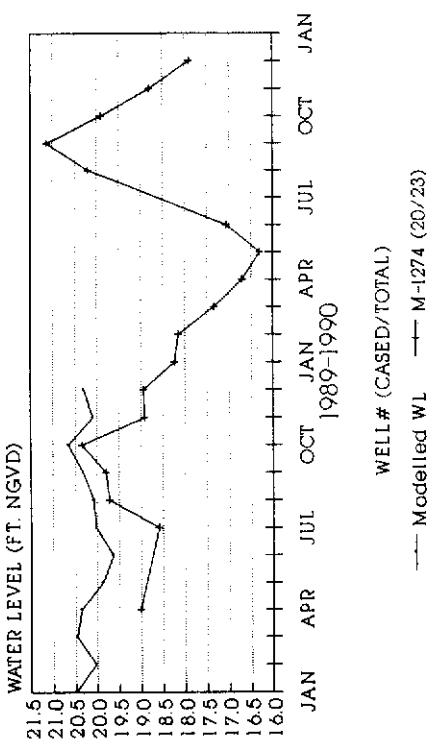
ROW 15, COLUMN 14



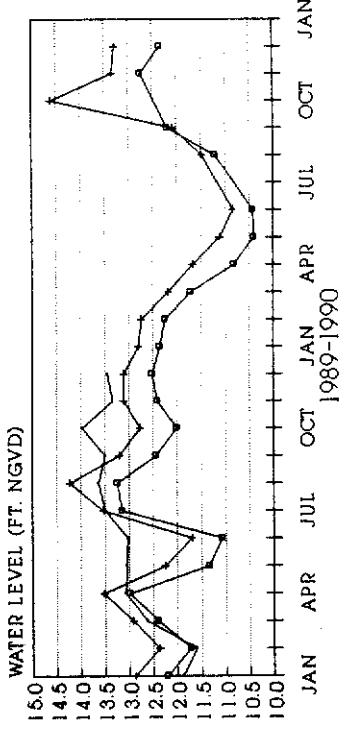
ROW 16, COLUMN 32



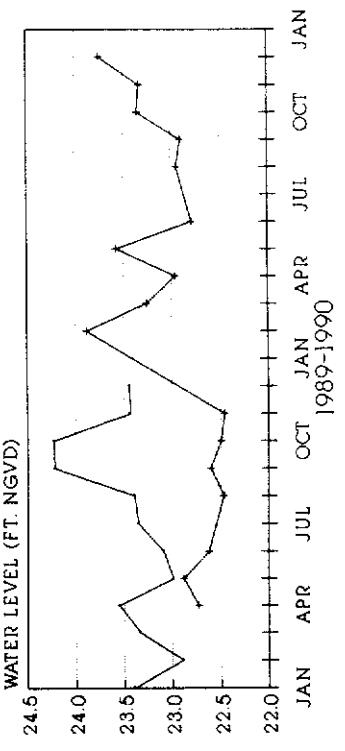
ROW 16, COLUMN 65



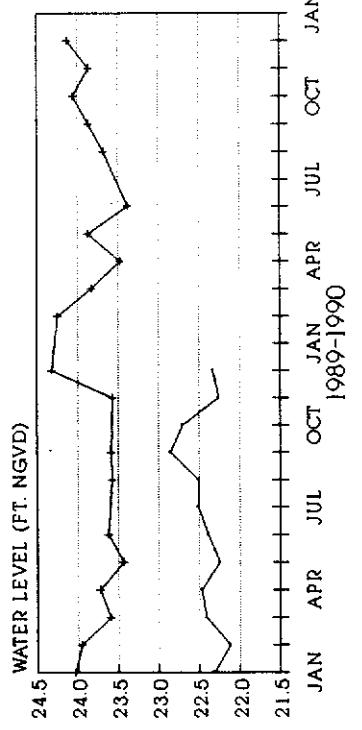
ROW 16, COLUMN 79



ROW 17, COLUMN 46

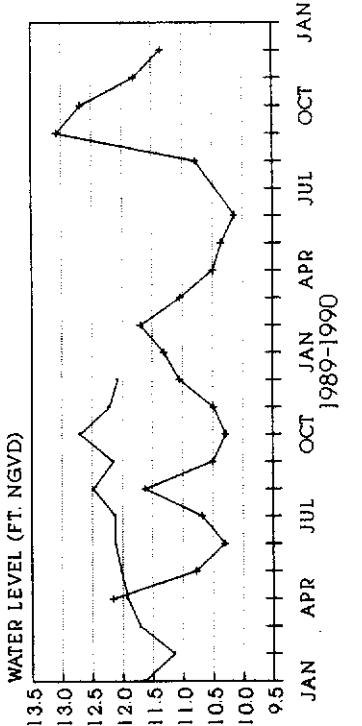


ROW 18, COLUMN 47



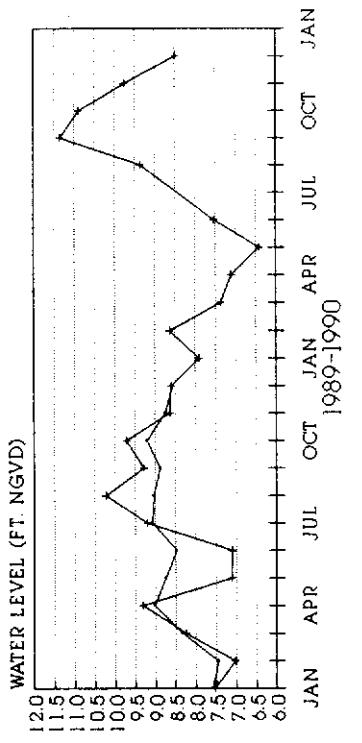
S.F.W.M.D.

ROW 19, COLUMN 90



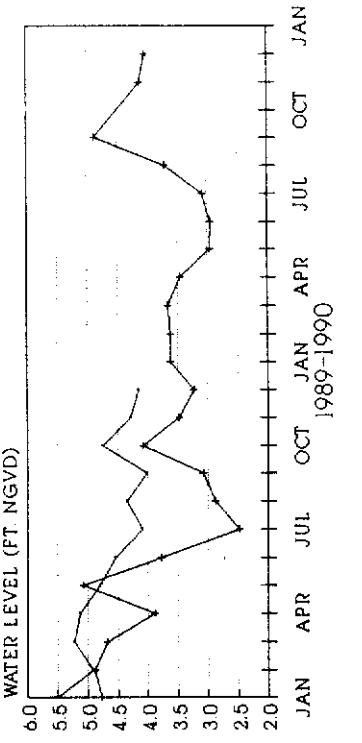
Great Pointeana Ln.

ROW 19, COLUMN 72



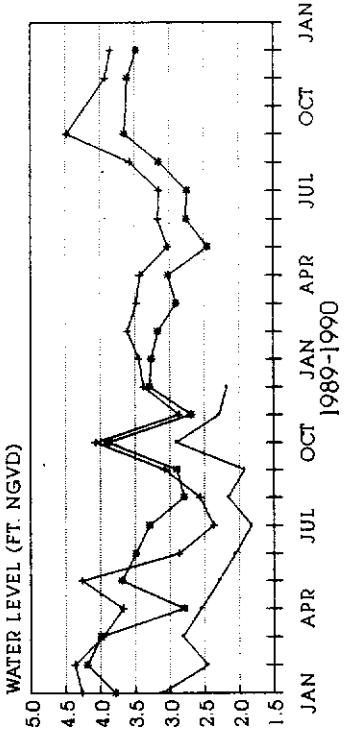
Locks Rd.

ROW 19, COLUMN 93

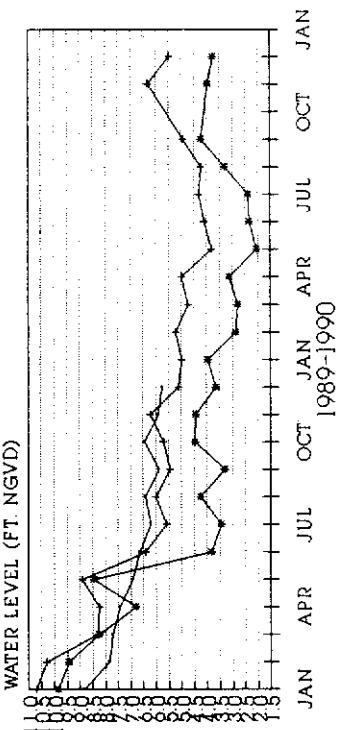


Hydraulisch

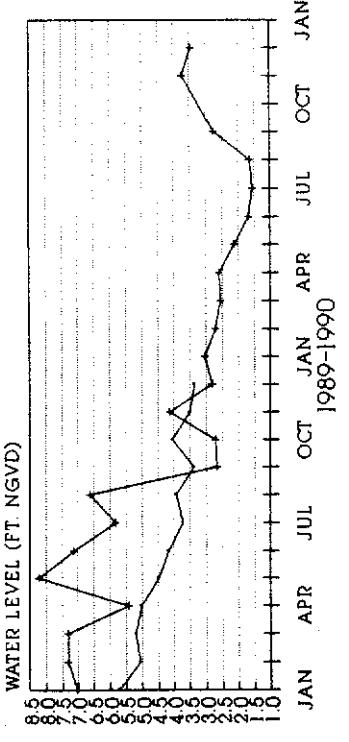
ROW 19, COLUMN 94



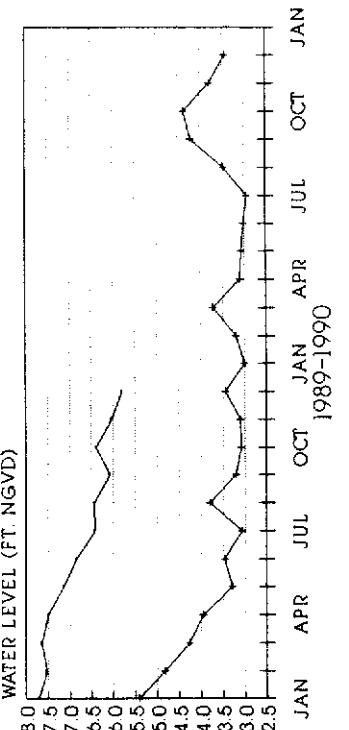
ROW 20, COLUMN 92



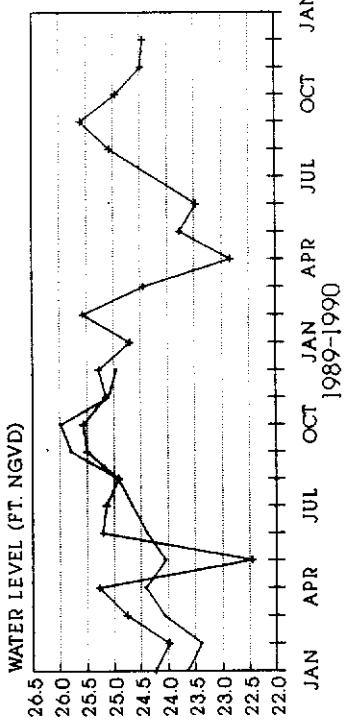
ROW 20, COLUMN 93



ROW 21, COLUMN 93

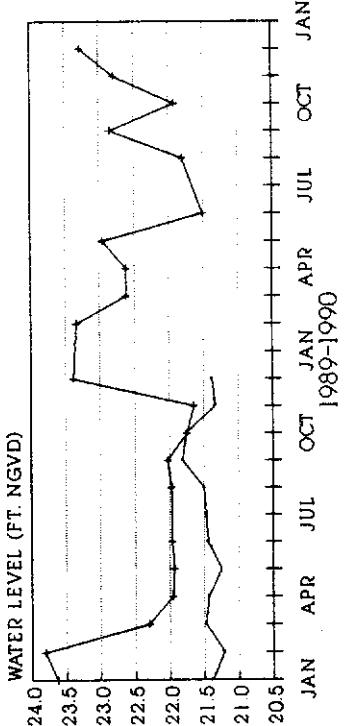


ROW 23, COLUMN 39



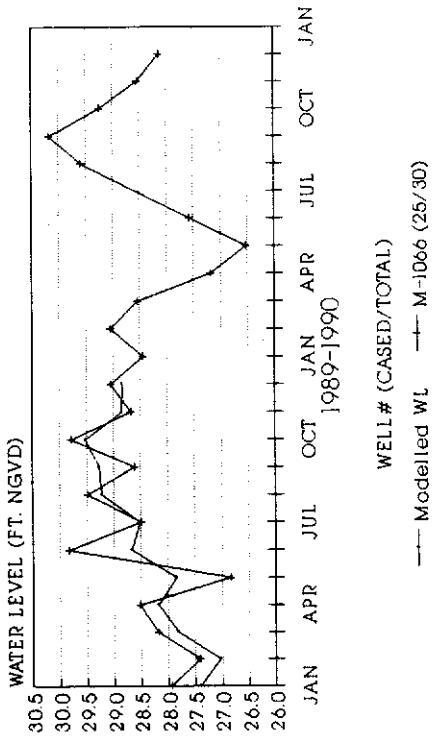
S.F.W.M.D.

ROW 25, COLUMN 47



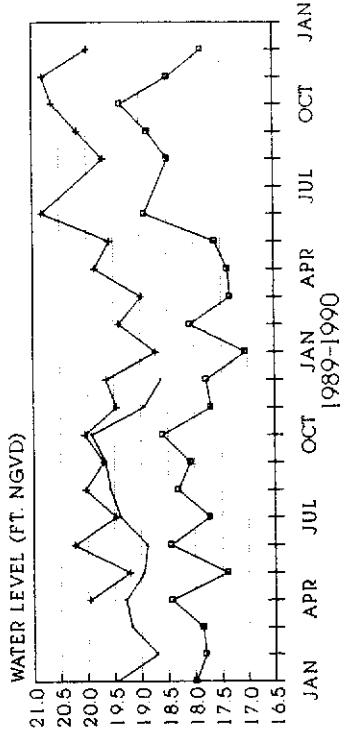
S. F. W., M.D.

ROW 24, COLUMN 27



SECTION Near Earth Giant

ROW 25, COLUMN 65

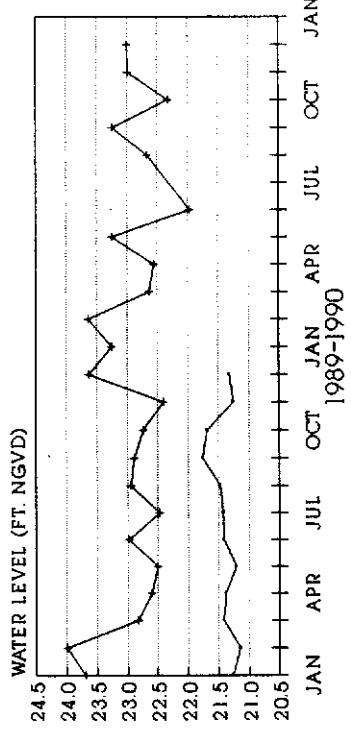


WELL# (CASED/TOTAL) → M-1273 (17/20) → M-1236 (105/116)

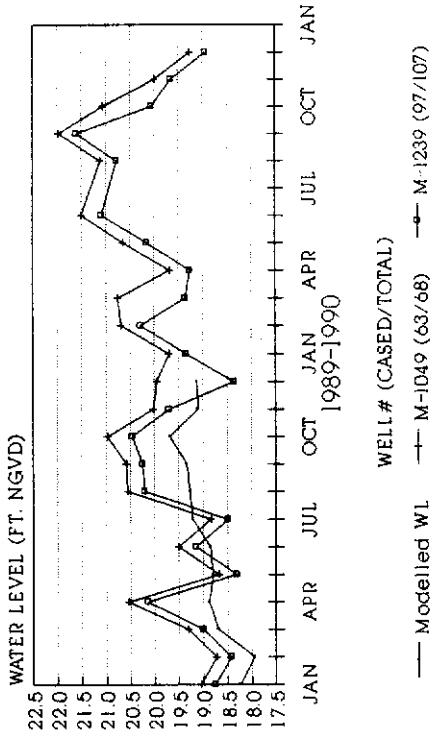
→ Modified WI

Citrus Blvd. • Becker Groves

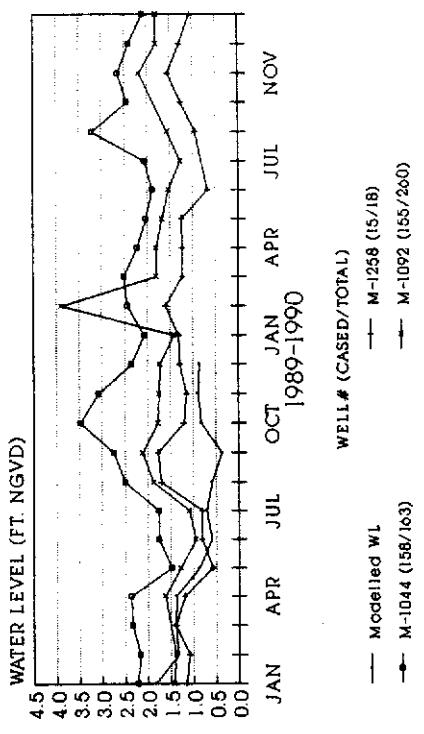
ROW 26, COLUMN 47



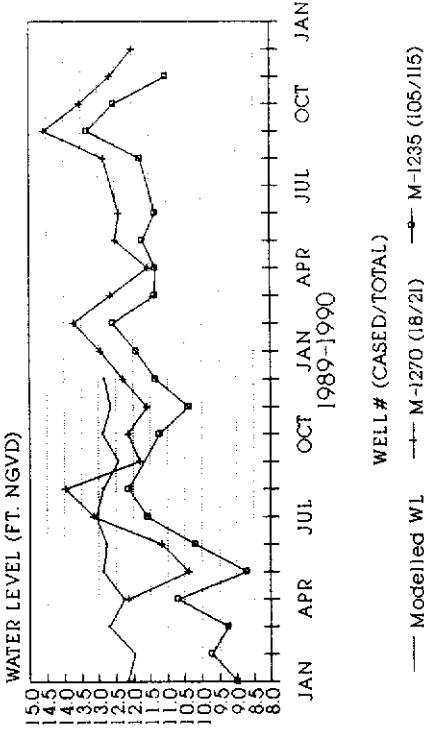
ROW 27, COLUMN 67



ROW 28, COLUMN 97

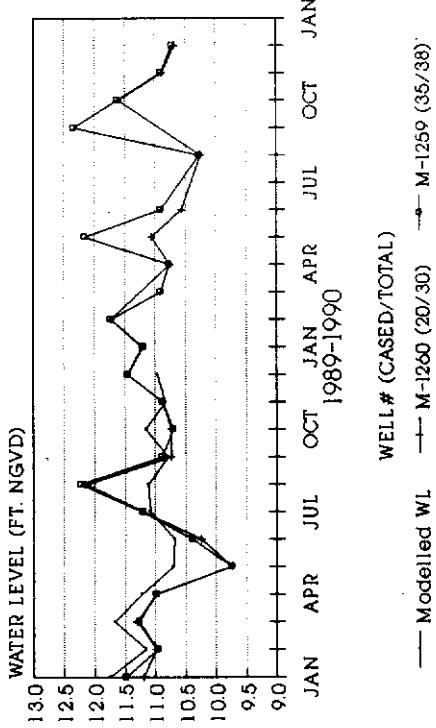


ROW 30, COLUMN 80



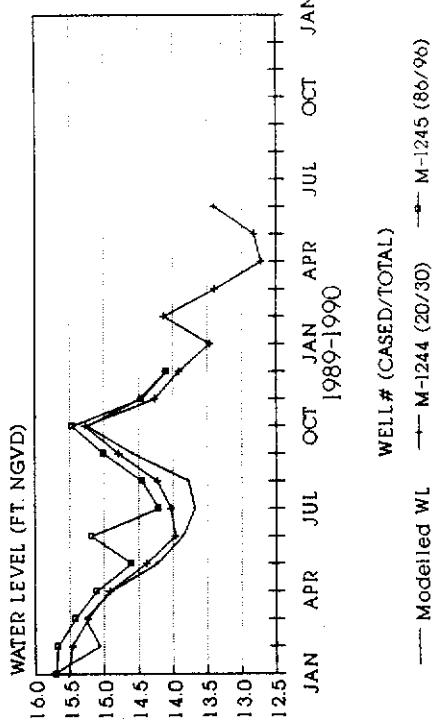
AIA Hobe Sound

ROW 30, COLUMN 91



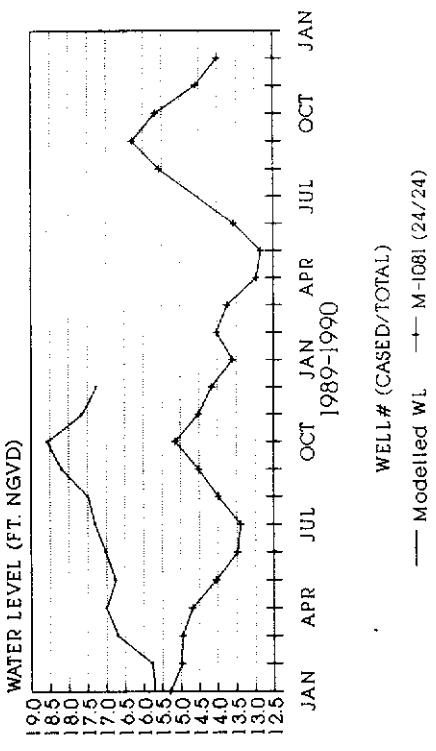
Bridge Rd. & Powerline Rd.

ROW 32, COLUMN 52



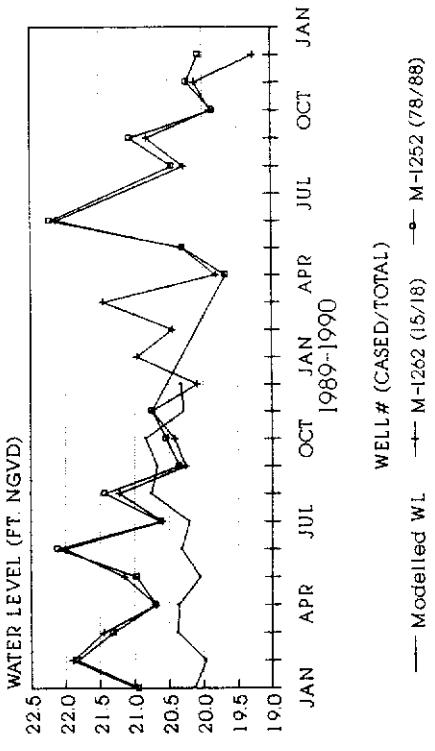
Citrus Blvd. Across From Caulkins Grove

ROW 31, COLUMN 57



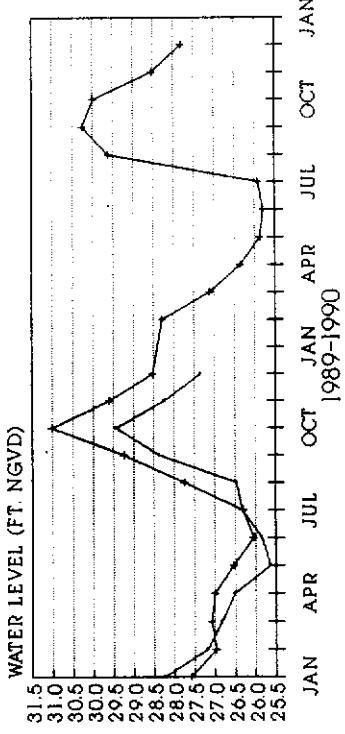
SR76 5 M1. East Of SR710

ROW 33, COLUMN 28



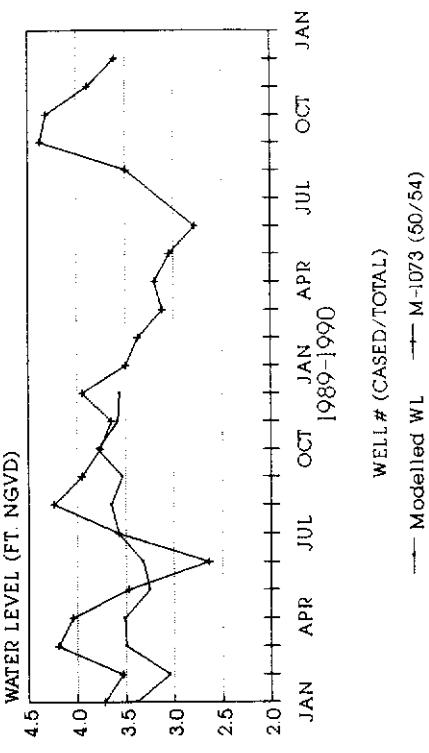
West Farms Rd. Indianlowr

ROW 34, COLUMN 41



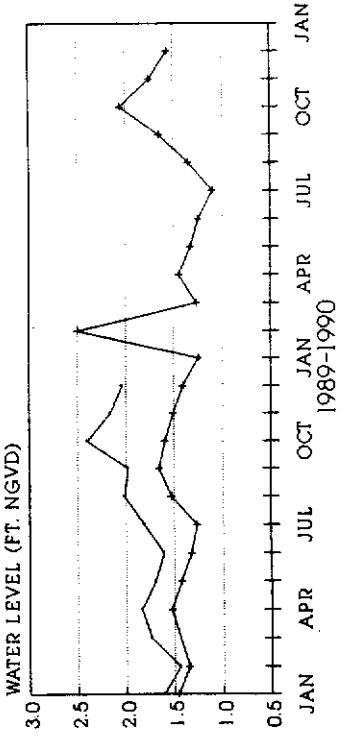
Indiantown Fire Station

ROW 34, COLUMN 98



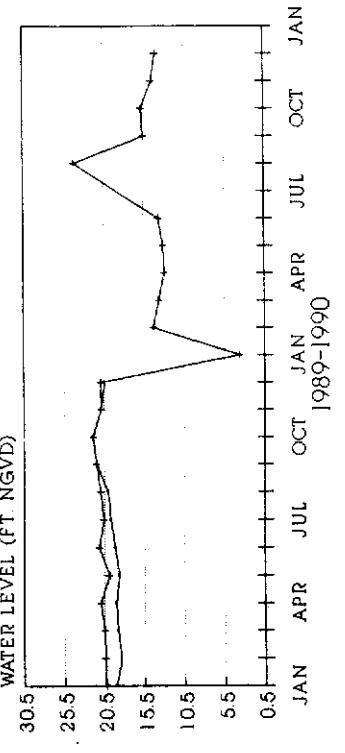
S.F.W.M.D.

ROW 36, COLUMN 100



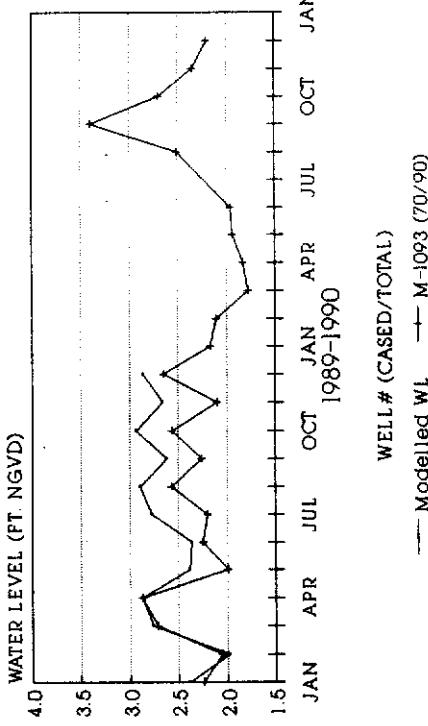
Hobe Sound

ROW 37, COLUMN 44

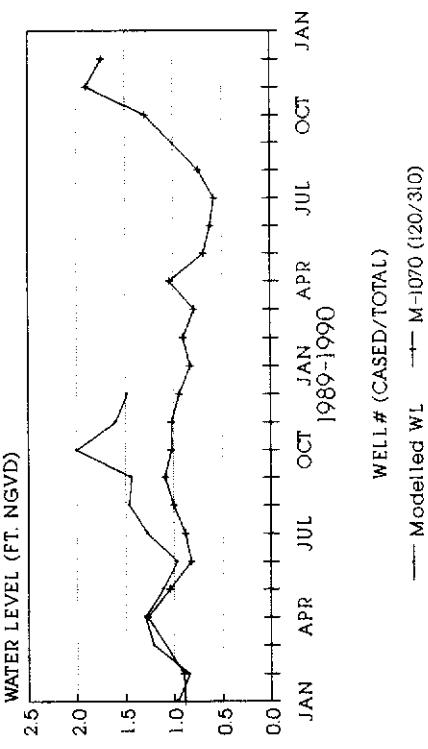


S.F.W.M.D.

ROW 37, COLUMN 99

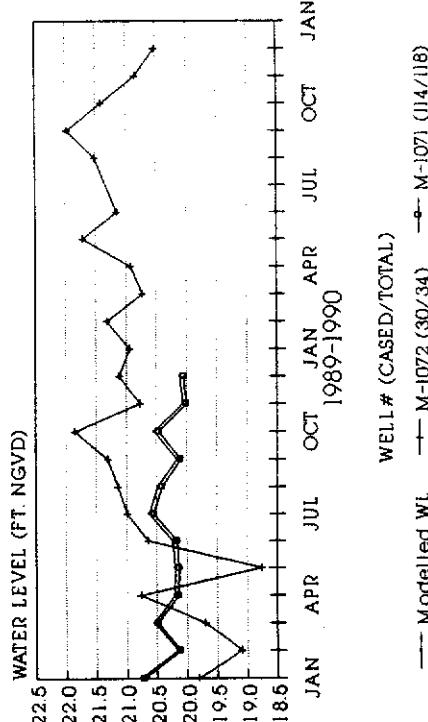


ROW 37, COLUMN 101



ROW 38, COLUMN 100

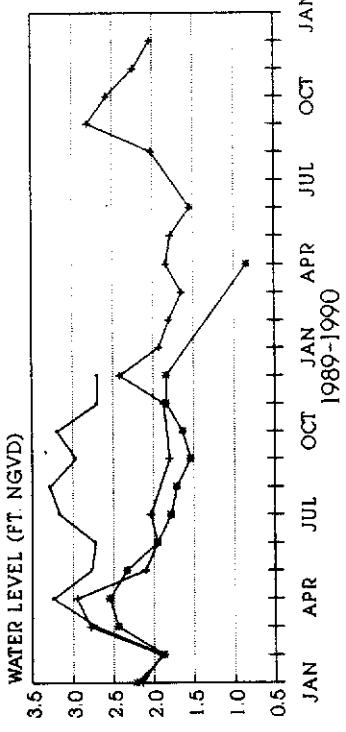
ROW 39, COLUMN 24



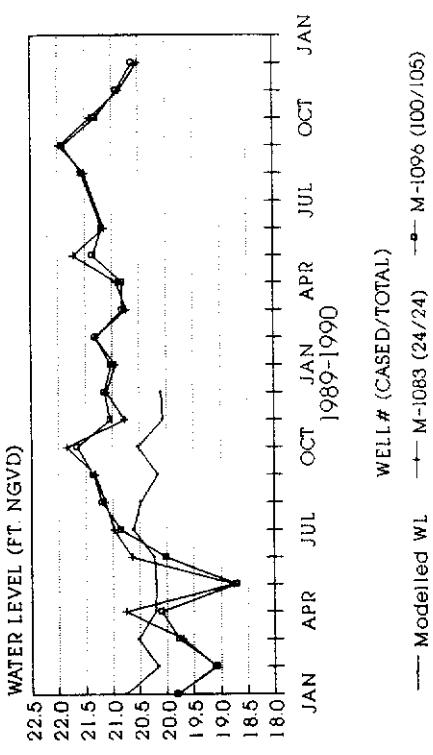
Jonathan Dickinson State Park

S.F.W.M.D.

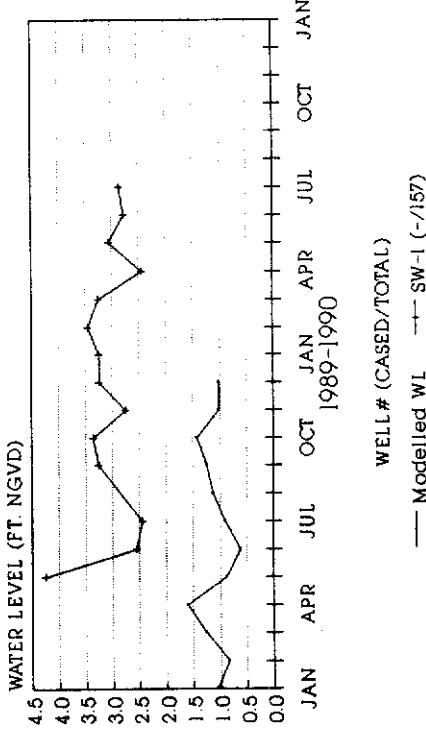
ROW 39, COLUMN 100



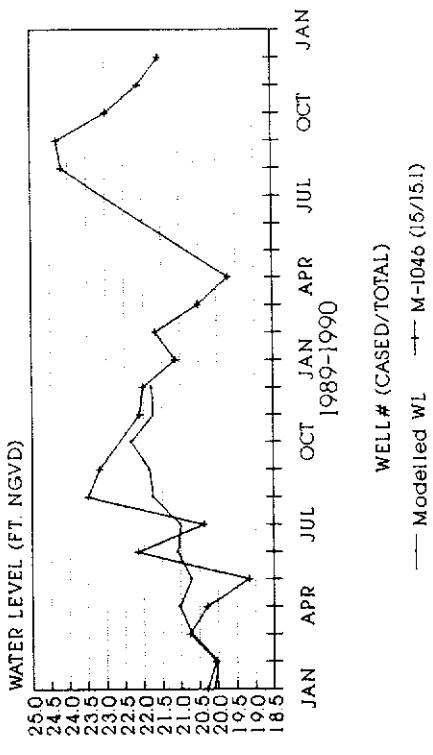
ROW 40, COLUMN 72



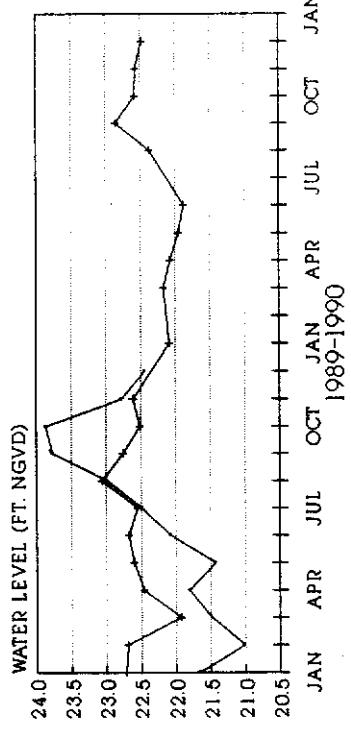
ROW 40, COLUMN 102



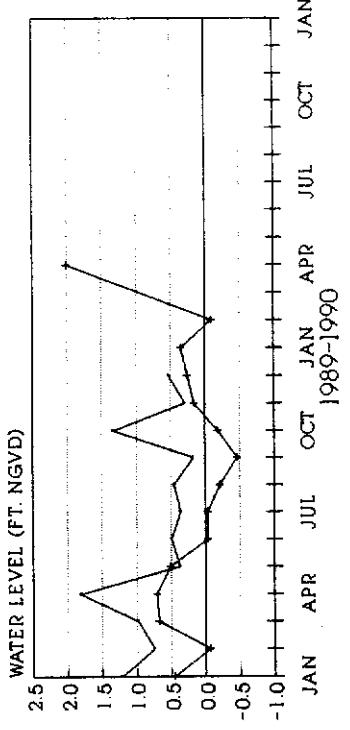
ROW 41, COLUMN 25



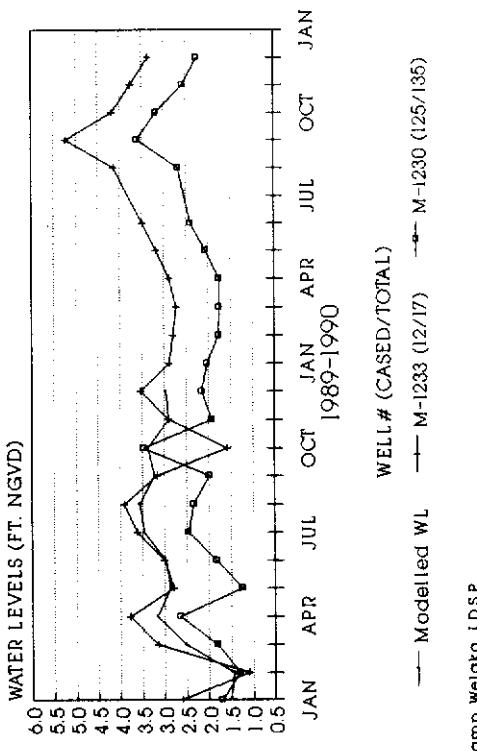
ROW 41, COLUMN 39



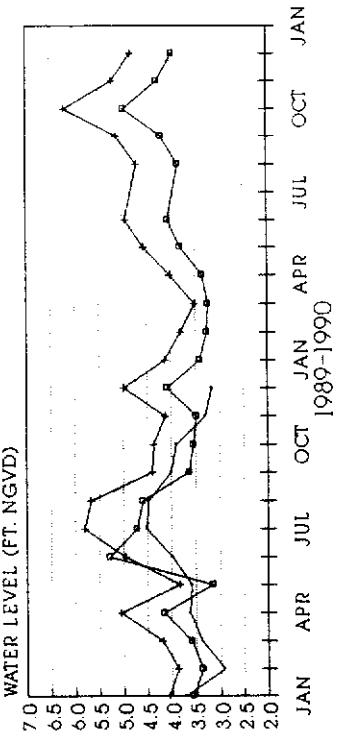
ROW 41, COLUMN 101



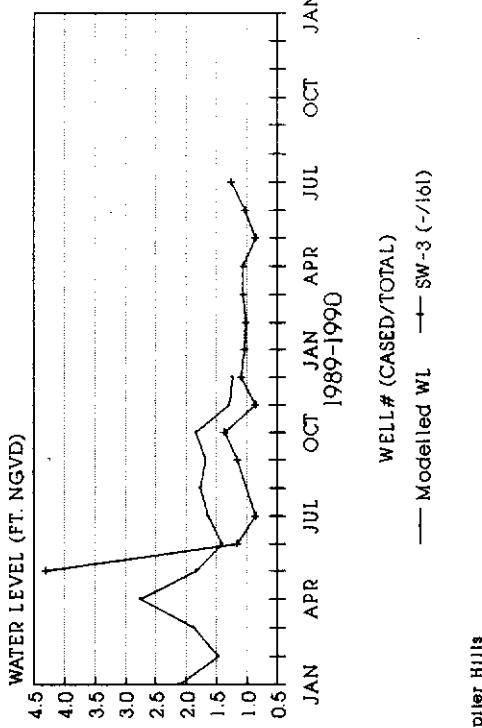
ROW 41, COLUMN 98



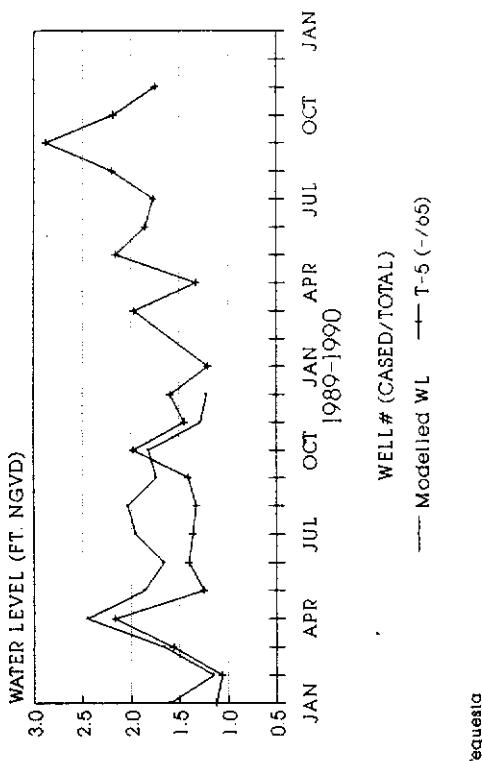
ROW 42, COLUMN 93



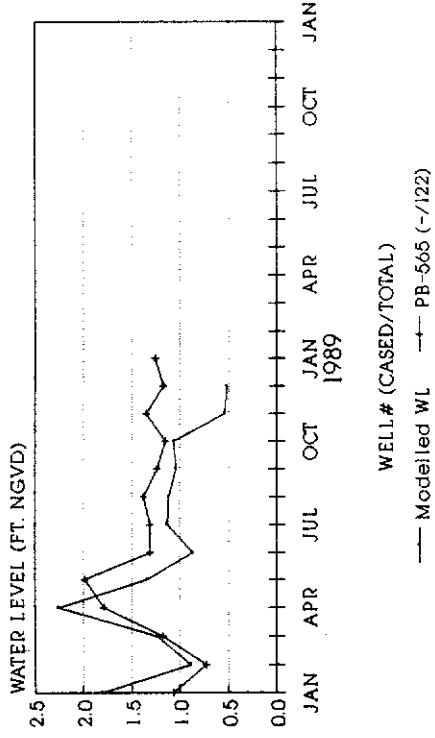
ROW 42, COLUMN 102



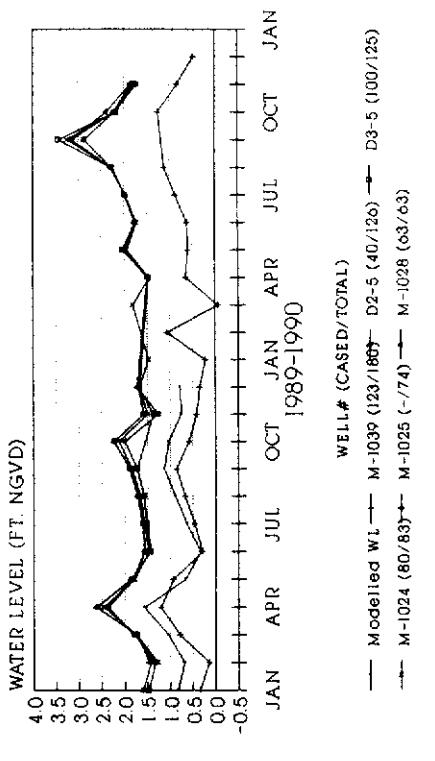
ROW 43, COLUMN 100



ROW 43, COLUMN 102

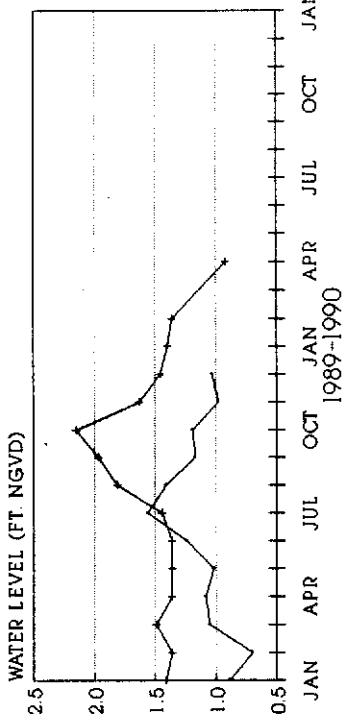


ROW 43, COLUMN 103

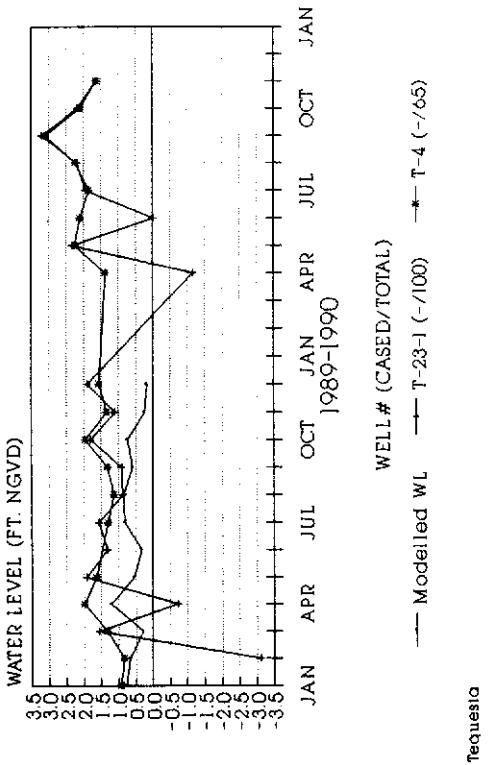


County Line Rd. & Old Dixie Hwy • R/R Tr

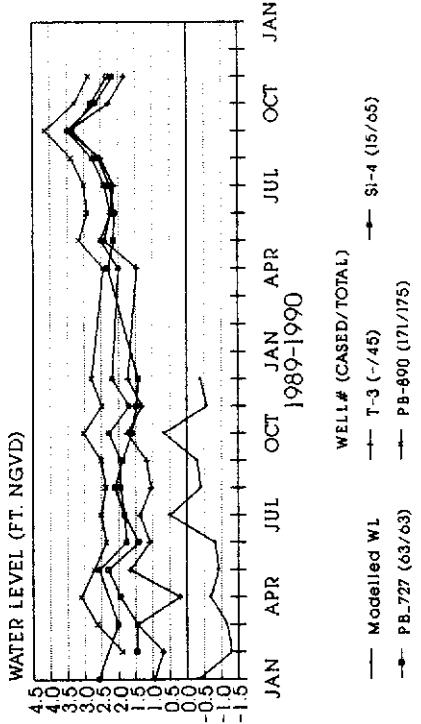
ROW 44, COLUMN 91



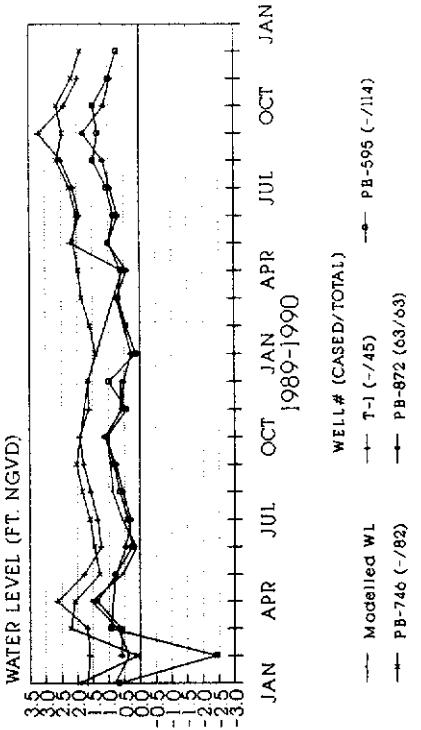
ROW 44, COLUMN 101



ROW 44, COLUMN 102



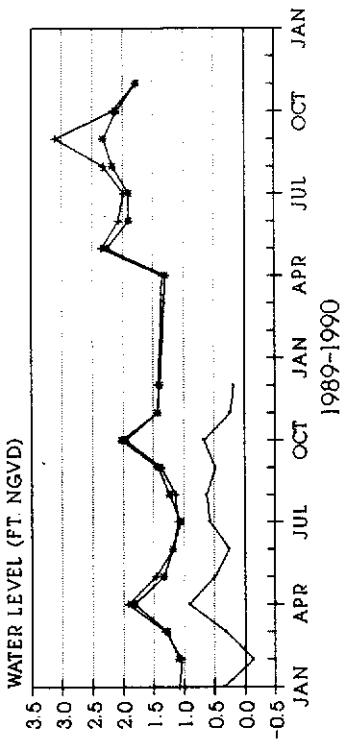
ROW 44, COLUMN 103



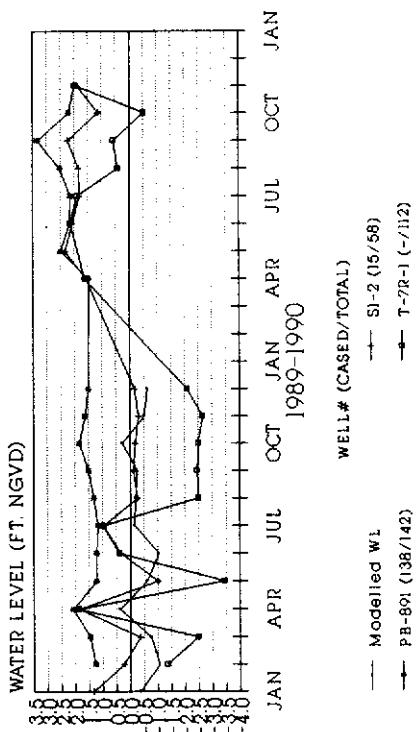
ROW 44, COLUMN 104

Tequesta
Loxahatchee River

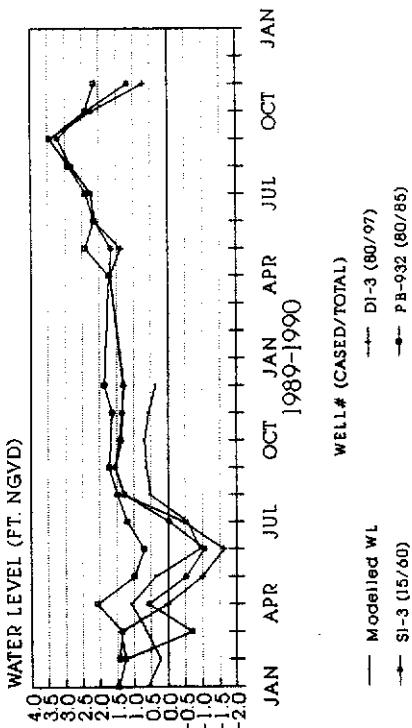
ROW 45, COLUMN 101



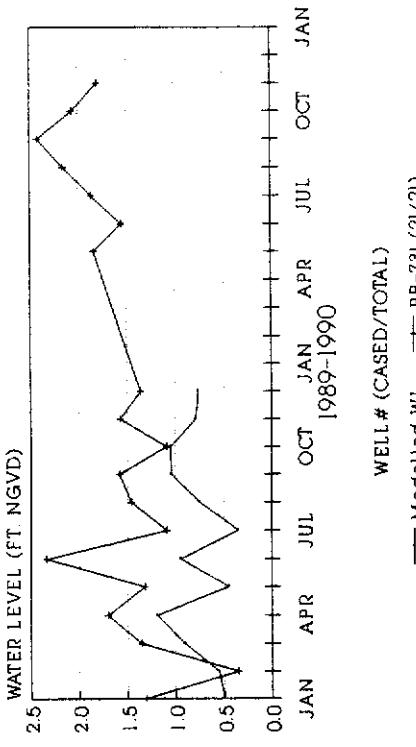
ROW 45, COLUMN 102



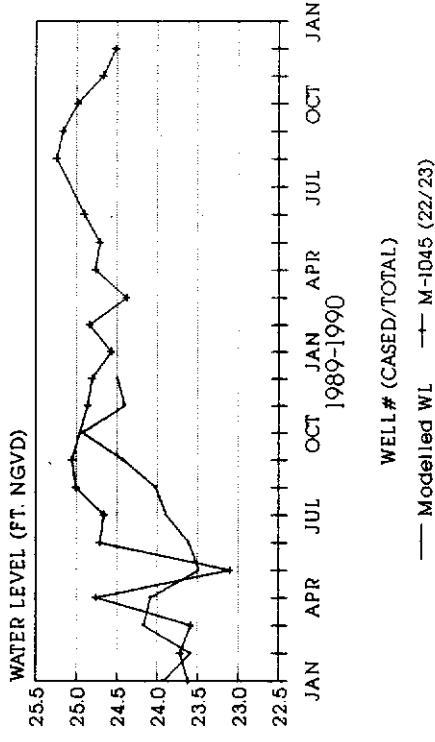
ROW 45, COLUMN 103



ROW 45, COLUMN 104



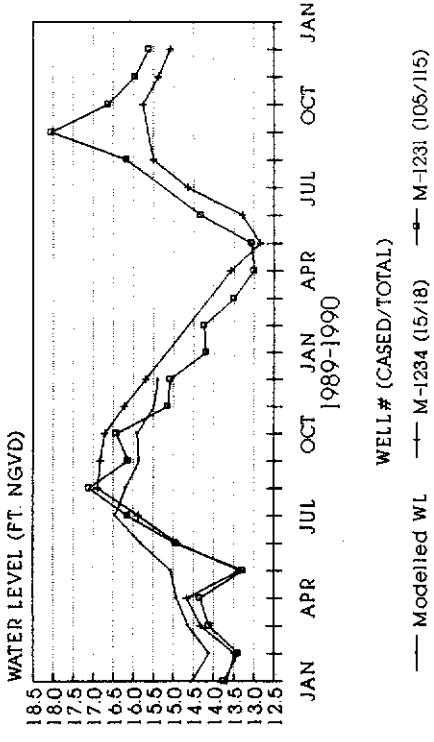
ROW 46, COLUMN 56



SR710 Martin / P.B. Co Line

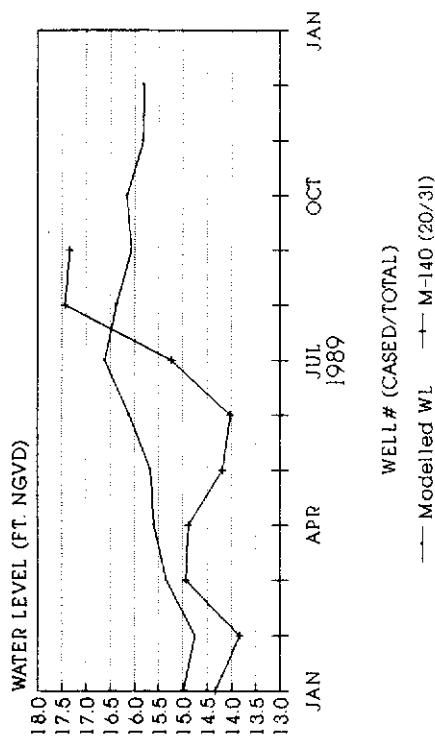
Old Indian Town Road

ROW 46, COLUMN 79



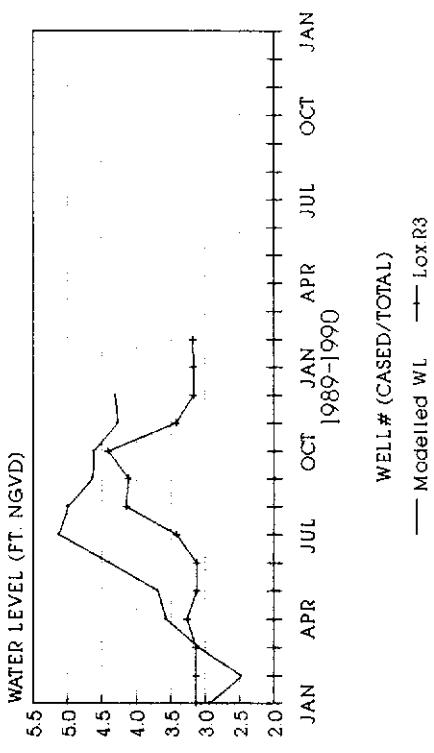
Old Indian Town Rd.

ROW 46, COLUMN 78



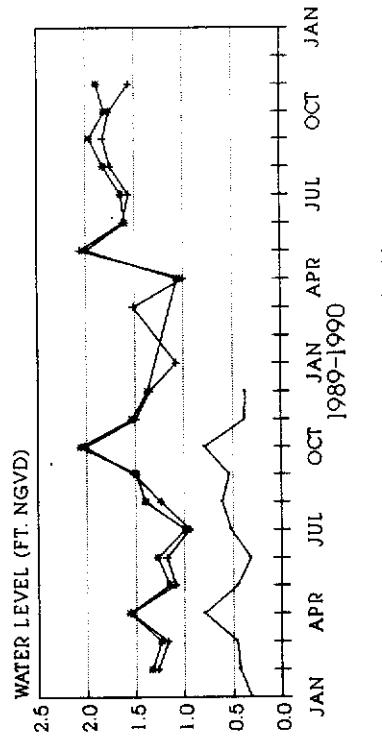
Old Indian Towns 103

ROW 46, COLUMN 90



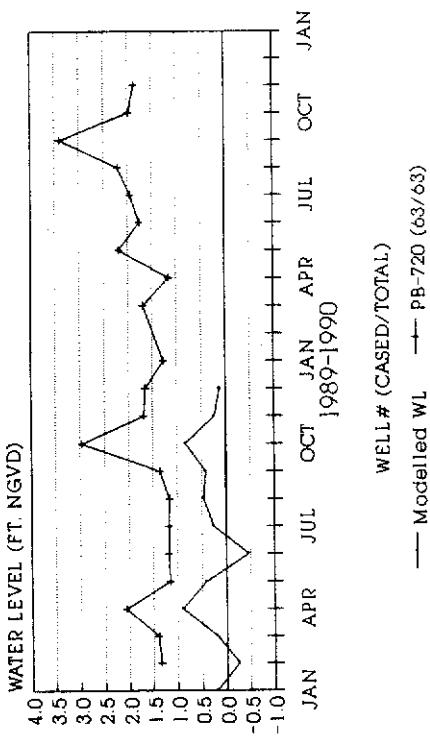
Lokahatchee River

ROW 46, COLUMN 101



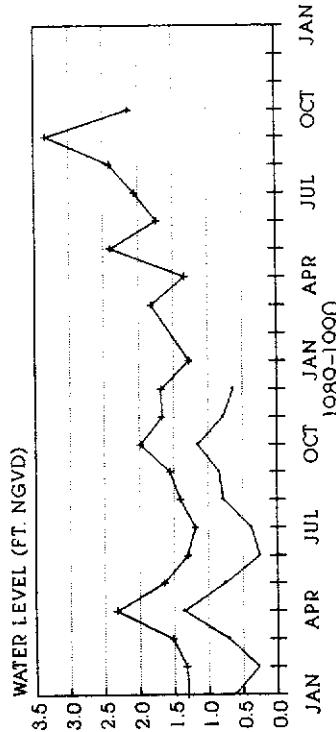
Tequesta

ROW 46, COLUMN 102



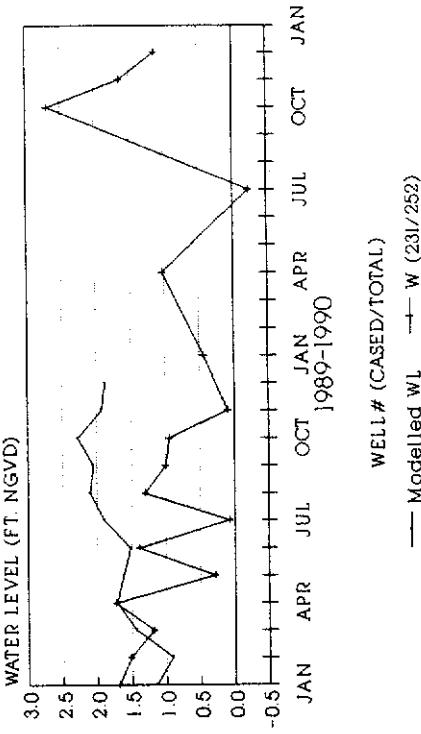
Tequesta

ROW 46, COLUMN 103



Tequesta

ROW 47, COLUMN 98



Jupiter

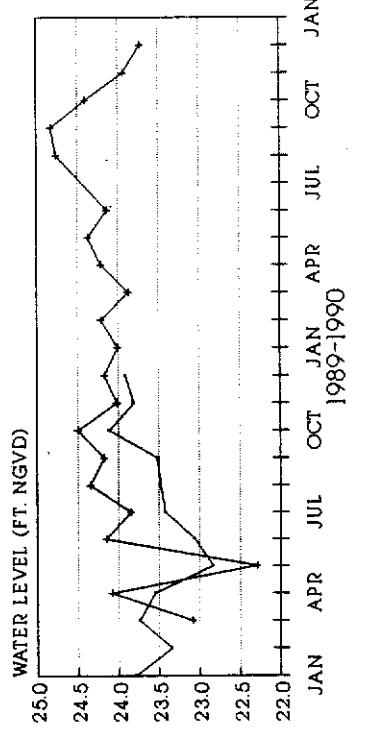
— Modelled WL → WELL# (CASED/TOTAL)

— Modelled WL → WELL# (CASED/TOTAL)

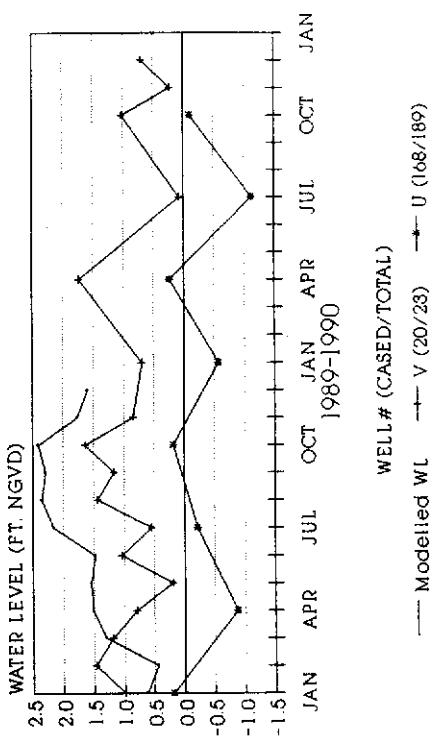
— Modelled WL → T-2 (-/-45)

— Modelled WL → W (231/252)

ROW 49, COLUMN 62

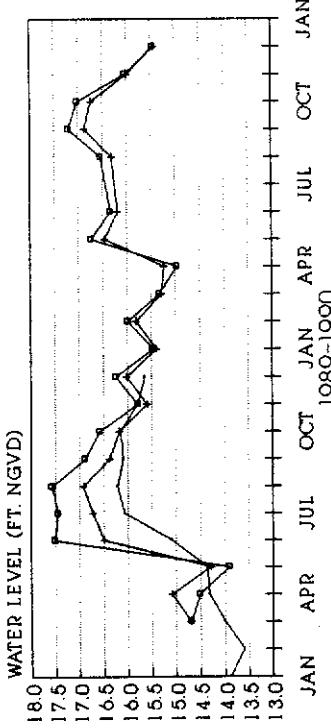


ROW 49, COLUMN 96



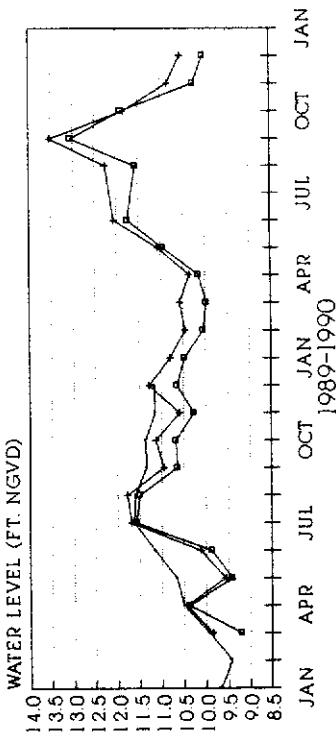
Jupiter

ROW 50, COLUMN 80



Mellon Lane • Canal (Jupiter Farms)

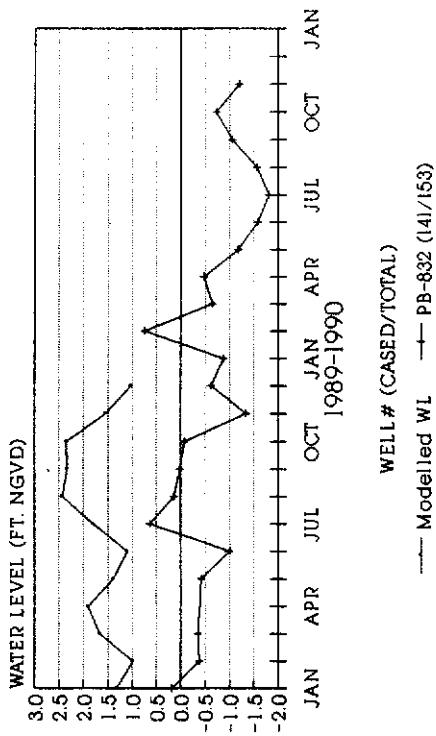
ROW 50, COLUMN 89



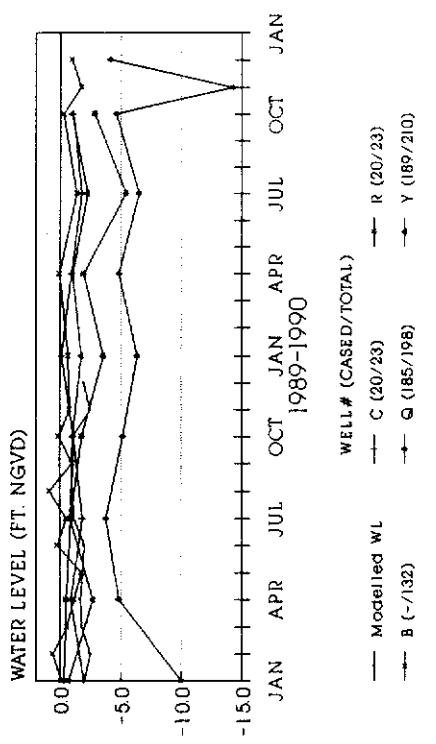
Riverbend Park

WELL# (CASED/TOTAL)
— Modelled WL → PB-1648 (17/20) → PB-1649 (-/165)

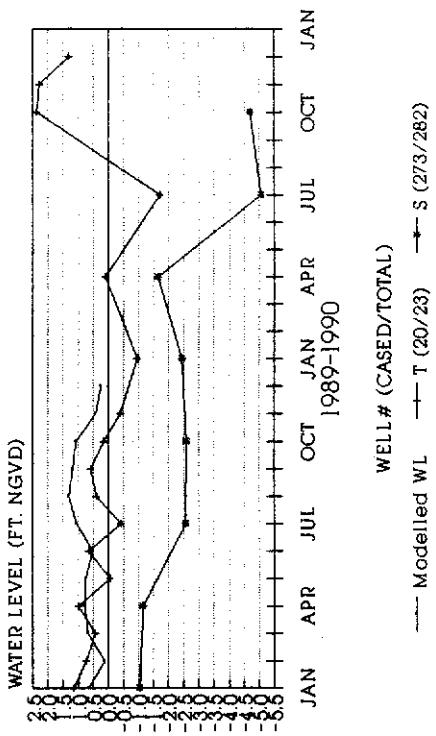
ROW 50, COLUMN 95



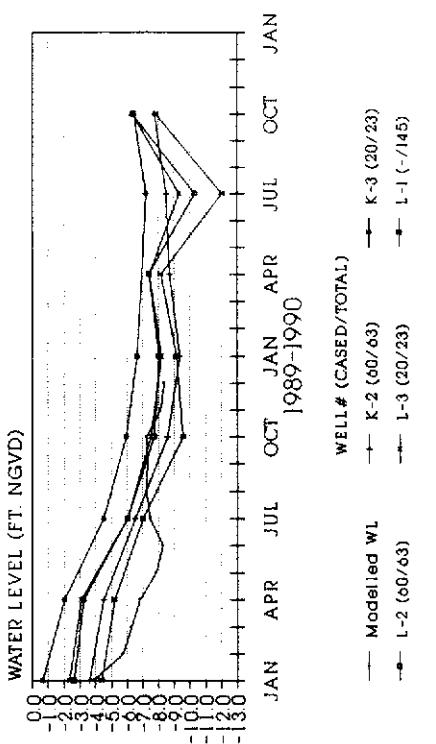
ROW 50, COLUMN 96



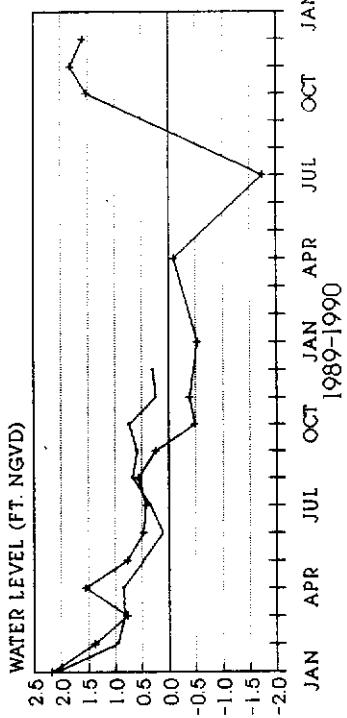
ROW 50, COLUMN 97



ROW 51, COLUMN 96

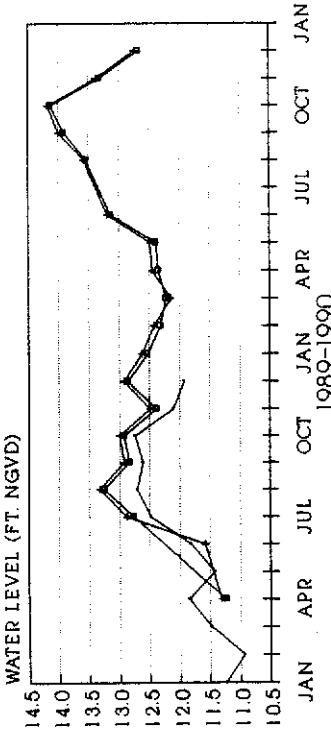


ROW 53, COLUMN 97



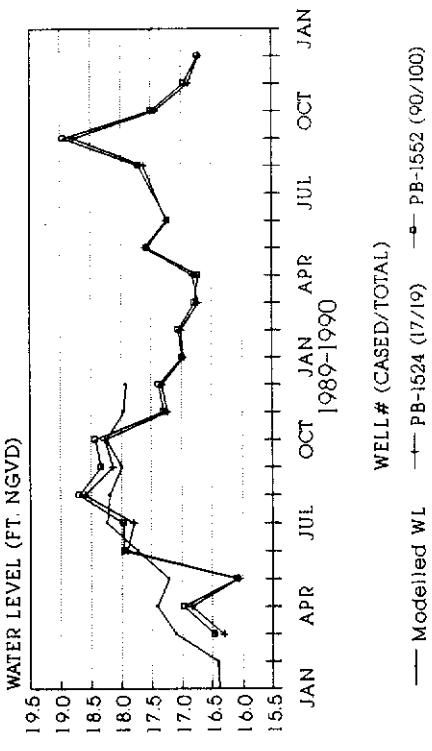
Jupiter

ROW 54, COLUMN 89



C-18 • G-92 Structure

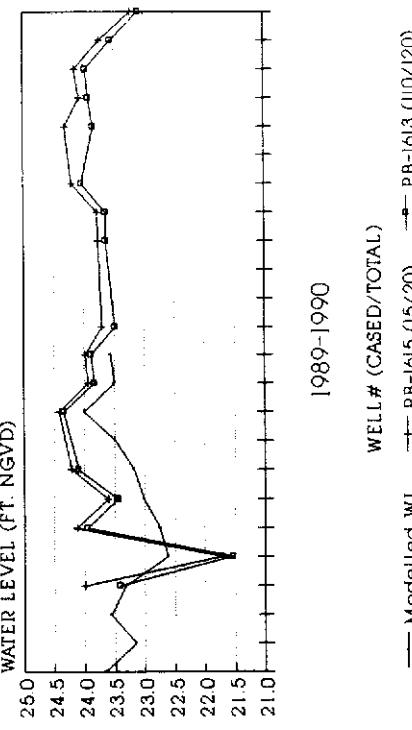
ROW 54, COLUMN 76



159 Ct. Off 133RD terrace

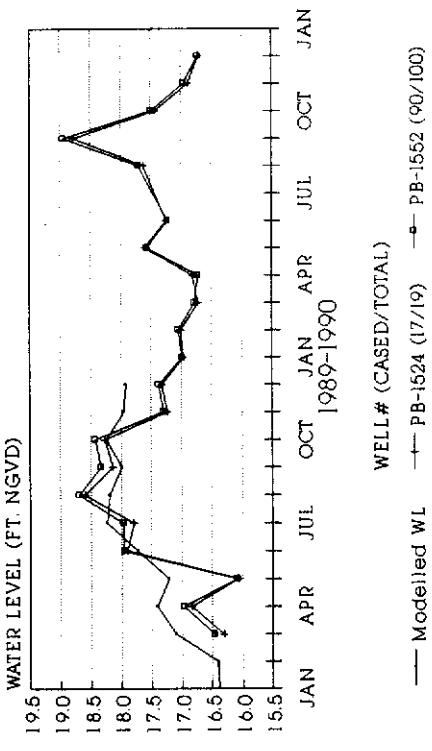
218

ROW 55, COLUMN 52

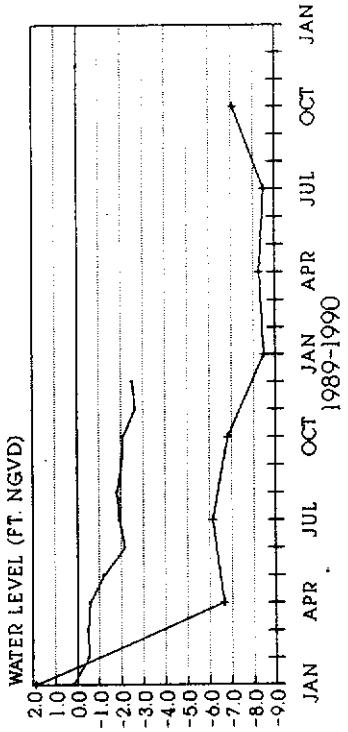


Corbett Area

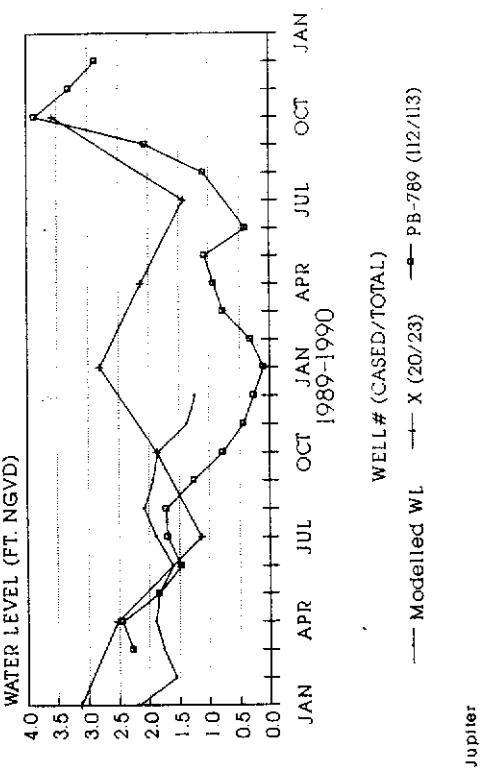
ROW 54, COLUMN 76



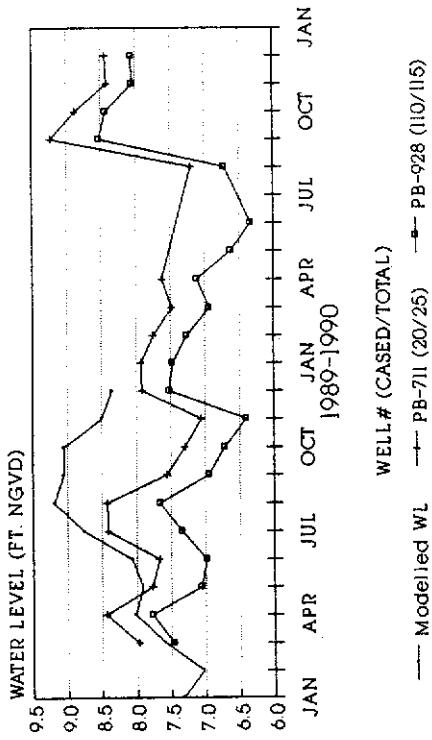
ROW 51, COLUMN 97



ROW 51, COLUMN 98



ROW 53, COLUMN 94



ROW 53, COLUMN 95

